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The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics

OCTOBER, 1923

TWINS AGAIN
A. E. WIGGAM

DOMINANT DWARFNESS IN OATS
T. R. STANTON

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Date of Issue of This Number, November 5, 1923.

TWINS FROM A TWIN-BEARING FAMILY

These boys came honestly by being twins. In fact, they were lucky not to have been quadruplets, for on their mother's side of the family are two cases of twinning, and on the father's side there are seven pairs of twins. Since Galton's pioneer studies regarding the similarities and differences of twins they have been of perpetual interest to students of heredity, and their popular interest antedates Galton thousands of years, at least. Later studies but serve to confirm Galton's original conclusion, "that nature prevails enormously over nurture, when the differences of nurture do not exceed what is commonly to be found among persons in the same rank in society and in the same country." (Frontispiece.) *See "Twins Again," by Albert Edward Wiggam, p.* 311.

THE THYROID GLAND AND DEVELOPMENT

FREDERICK S. HAMMETT

The Wistar Institute of Anatomy and Biology, Philadelphia

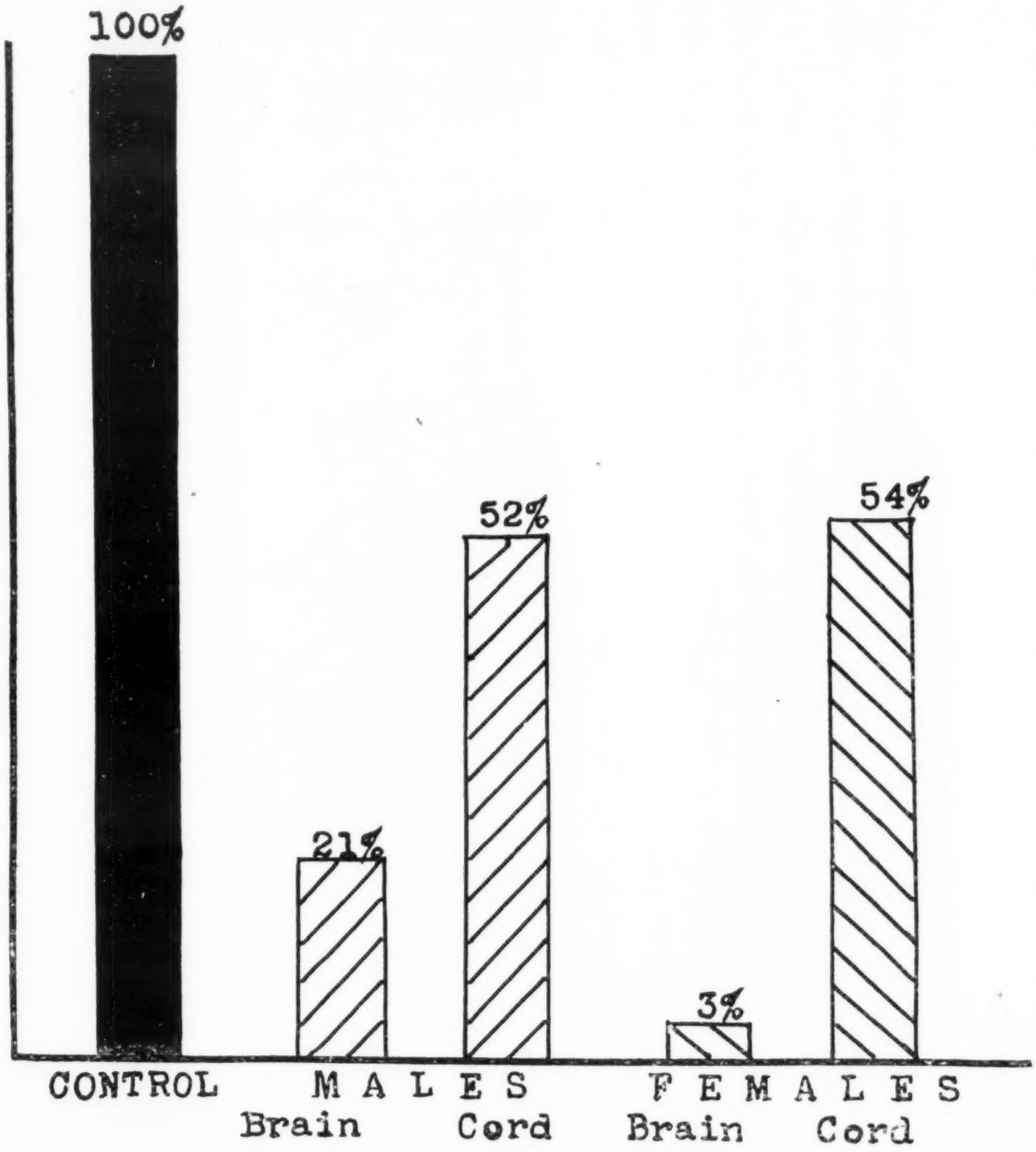
DEVELOPMENT is both qualitative and quantitative. The type and functional aspects of development are qualitative. The extent and rate of development are quantitative. Qualitative development is specific and normally fixed. Quantitative development is specific as to its limitations but is subject to variation due to the environmental influences of diet, exercise, toxemia, and so forth. The fundamental type of structure and function characteristic for a given species is what sets the species apart. The differences in extent and rate of development of individual organisms within a species are causes of the variations within the species. These variations may be proportionate or disproportionate. Proportionate variation occurs when inter-organic differential development differs in absolute but not in relative value. Such variation gives rise to a series of individuals differing in absolute size, but not in the relative sizes of the constituent parts of the individual. Disproportionate variation occurs when the rate or extent of development of one or more parts of an individual with respect to other parts of the same individual, differ from the rate or extent of development of the same parts in another individual with respect to its other parts.

Disproportionate developmental variation gives rise to groups of individuals which for want of a better term have been designated as "types" within a species. These "types" differ from each other in bodily proportions, but the fundamental specific type is the same in all. That is to say, the qualitative development is the same, while the quantitative differential development is different. An instructive classification along these latter lines has been given by Stockard in his broad division of man into the "Linear" and the "Lateral" type of structure.

Much interesting speculation has been made of the role of the thyroid gland in "type" development of man. This, as should be clear from the foregoing, is actually a question of the part played by thyroid activity in differential development, which in turn is largely a phase of quantitative, not of qualitative development. Although it is possible that thyroid function is associated with qualitative development, there is no evidence at present available which would justify the allocation of any definite influence of that gland on this phase of growth.

On the other hand, it is possible to show that thyroid activity is a factor of great importance in quantitative differential development. It seems best, therefore, at the present time, to confine ourselves to an interpretation of known facts, rather than to attempt the elaboration of an hypothesis for which no adequate experimental data are available.

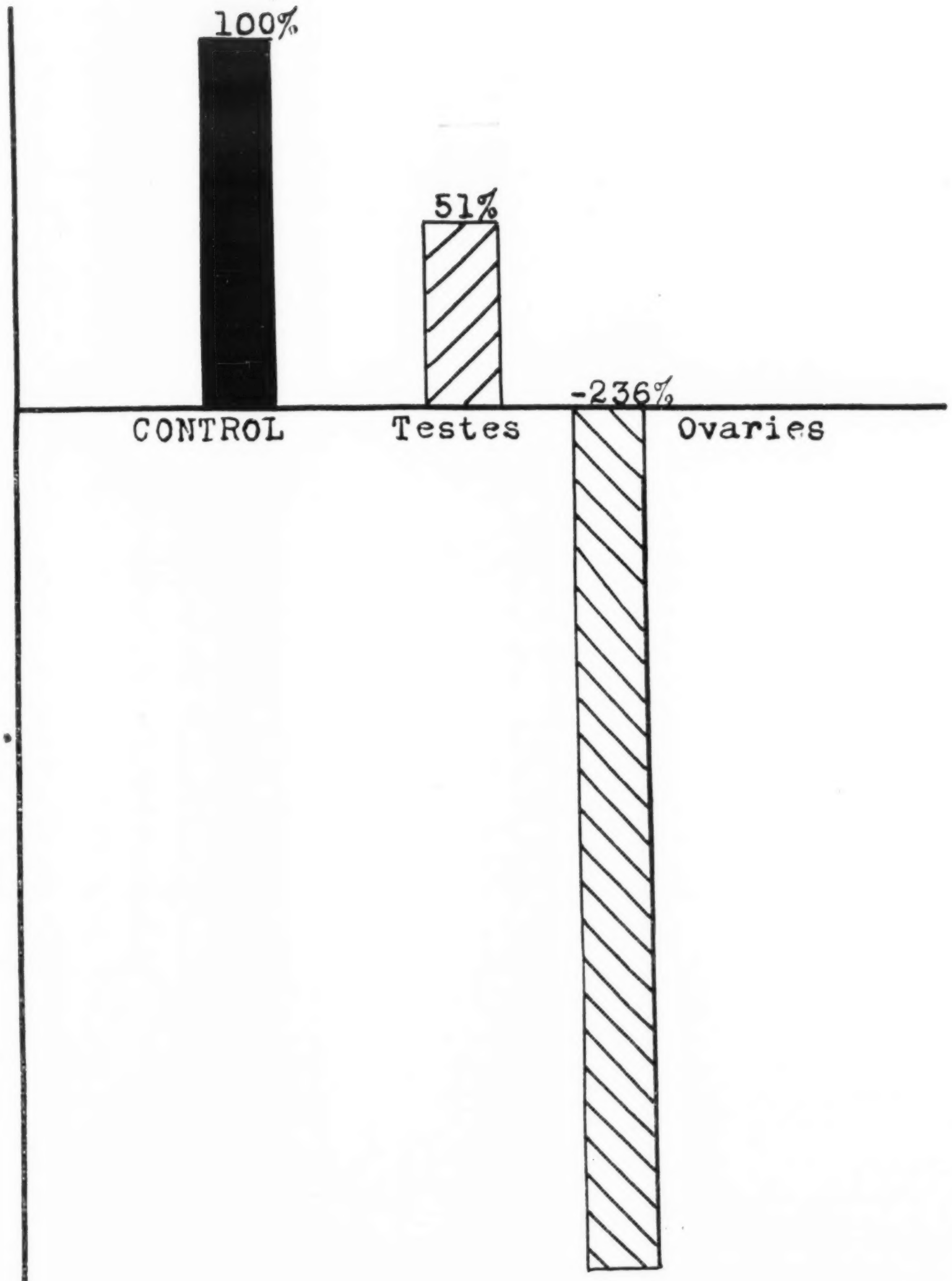
Other things being equal, quantitative development depends on the kind and amount of food ingested by the individual, although there is, of course, a specific limitation of the size to which an organism can grow. Quantitative development is thus intimately associated with metabolism. There is a certain fundamental type of metabolism common to all the living cells of the organism. It is known that a function of the thyroid gland is con-



GROWTH OF BRAIN CONTROLLED BY THYROID GLAND

FIGURE 1. In this chart the brain and spinal cord are considered as separate organs of the nervous system. The operated white rats had their thyroid glands and the parathroids removed, and the effect of thyroid removal was determined by a comparison with litter controls fifty days later. The spinal cord, which controls reflex nervous activities of the organism, represents an older and relatively less differentiated part of the nervous system than the brain, in which are centered the higher mental functions. Cretins show a nearly normal development of the "cordal" nervous reactions, but an almost total absence of cerebral functions. These experiments indicate why this should be so.

cerned in the maintenance of an adequate level of this basal metabolism. In addition to, or along with this common type of metabolism, there is evident in each individual organ a specific type which is characteristic for the organ in question in the nature of its assimilative and productive phases. The adrenals produce adrenin, the pancreas secretes trypsin, the liver assimilates glucose and stores it as glycogen, and so on. It is probable, though not yet demonstrated, that thyroid gland activity has an influence upon the specific as well as the general metabolism of the individual organs. It is, however, evident that the thyroid gland, through its relations to the metabolic processes of the body as a whole and of its parts,



EFFECT OF THYROID GLAND ON GROWTH OF THE GONADS

FIGURE 2. In these white rats the removal of the thyroid and parathyroid glands has resulted in the male gonads reaching only about half the normal development, and in actual degeneration and atrophy of the female reproductive organs. Goiter and other diseases of the thyroid are much more frequent among woman than among men, and the break-down of the thyroid coincides generally with a period of change or stress in the female reproductive system. These charts show that a much closer relation exists between the reproductive system and the thyroid in the female than in the male.

is intimately concerned with quantitative development.

Clinical observations on man and extirpation experiments on animals have established the fact that a deficient thyroid secretion results in a marked retardation of body growth. It should be noted that present evidence supports the belief that the retardation accompanying thyroid deficiency is a consequence of the lowered plane of general metabolism. The earlier idea that the thyroid gland produces a secretion specifically stimulative of growth has yet to be substantiated.

The studies of Swingle and others have demonstrated the significant role of the thyroid in differential development of amphibia in relation to metamorphosis. No systematic quantitative studies of the part played by the gland in differential development of mammals had been made up to somewhat over three years ago when I began experiments, the detailed results of which are being published in a series of papers in other journals. The plan of the investigation and the procedures employed are to be found in these communications. This paper deals with two of the striking evidences of the dependence of normal differential development on thyroid function and certain implications to be derived therefrom. The observations were made on albino rats of both sexes, adequately controlled as to litter, sex, age, diet, and environment, during the growth period from 100 to 150 days of age. The test, or thyroidless rats, were deprived of the thyroid apparatus (thyroid plus parathyroids) when 100 days of age and allowed to grow until 150 days old when they were killed and the appropriate measurements made. The values so obtained were compared with those obtained from the unoperated controls.

It was found, as others have found, that the loss of the thyroid secretion caused a marked retardation in the growth in weight of the body as a whole. That is to say, total quantitative development was retarded. In addition is was found that the retardation was not a simple proportionate retardation in which the organism at the terminal stage showed the same relative composition as the control. The various organs differed in the degree of their response to the thyroid deficiency. The various organs did not show proportionate degrees of retardation of the rate and extent of development. Disproportionate variation in the development of different organs was caused. A "type" of organism resulted which was different from the normal for the group from which the test animals came. When the internal environment was altered by the removal of the thyroid apparatus a differentiation of development obtained.

This effect is quite marked in the growth of the central nervous system, as represented by the brain and spinal cord, taken as separate organs.

In order that the effect and its extent may be made clear, there is given in Figure 1 the growth of the brain and spinal cord of the thyroidless rats in terms of the growth of these structures in the controls. The solid black column represents the growth in controls as 100 per cent. The heights of the other columns represent the degree of development of the brain and spinal cord of the male and female thyroidless rats, or the degree to which these organs failed to reach the normal level.

From the chart it is at once evident that the removal of the thyroid function does not have the same quantitative effect upon the development, as measured by the weight, of the brain as it does upon the spinal cord. The growth of the former is much more markedly retarded than is the growth of the latter. The lack of thyroid secretion caused a disproportionate variation in the differential development of these two parts of the nervous system of one and the same individual.

Effect of Thyroid Deficiency on Mentality

These observations are in line with clinical reports of the relative physical and psychic development of cretins. It is a generally accepted theory that cretinism is a result of deficient thyroid activity. This theory is based on the fact that a high incidence of thyroid disturbance, as expressed by thyroid hypertrophy, is usually found in the region where cretinism exists, and that certain post-mortem examinations of cretins show either the entire absence of functioning thyroid tissue, or a thyroid gland of very small size and abnormal structure. One of the marked characteristics of the cretins is the low mentality and usually small size of the skull cavity and brain. These individuals also show a retardation of general growth. However, from a standpoint of function, their physiological and reflex activities as mediated by the spinal cord, are apparently present in the normal state of development, while their psychic or cerebral potentialities are decidedly underdeveloped.

It is hazardous to associate size development with functional development in a heterogeneous stock. The rats which were used in my experiments, however, came from a stock which was highly homogeneous and the controls were litter controls. It is, therefore, not an expansion into improbability to consider that along with the greater retardation of brain growth there was a greater retardation of brain function. If this assumption is correct the differential effects on the central nervous system of thyroid deficiency experimentally produced in albino rats, are quits analogous to the effects of a thyroid deficiency on the same structures in cretins.

The Thyroid and Sex

In addition to the difference in retardation of brain and spinal cord in one and the same animal there is exhibited a sex difference in that in the females the retardation of the brain is more marked than in the males. It might be noted here that this sex difference in developmental rate is not confined to the brain but is a general phenomenon exhibited by practically all the organs.

This sex difference is shown in the greatest degree in the response of the gonads to the thyroid deficiency. The development of the testes and ovaries of the thyroidless rats is given in Figure 2 in terms of that of these organs in their respective controls.

It is evident that the development of the male gonads is but little retarded by the lack of thyroid secretion, while the development of the female gonads is not only absolutely inhibited, but retrogressive changes occur and weight is lost. The actual values mean that the growth of the testes in the male thyroidless rats was fifty-one per cent of that of the controls for the same age period, while the ovaries of the female thyroidless rats actually lost in weight over twice as much as was gained by their controls.

This specific sex difference points to the reason why thyroid disturbances, particularly goiter, are more frequent in women than in men. Clinical observations show that coincident with alterations in the physiological activity of the ovaries, such as occur at puberty, menstruation, pregnancy, and the menopause, there are often changes in the size of the thyroid. No such cyclic changes in thyroid size have been demonstrated in men. Correlating these phenomena with those observed in the developmental differences in the gonads of the two sexes in the albino rat, it is evident that in the male there is little interrelationship between the thyroid gland and the testes, while in the female a high degree of association is shown to exist.

This difference in response of the gonads of the two sexes to the thyroid function suggests that if thyroid defects are transmissible, the line of

influence is largely through the female. This idea is pure speculation. The data now available do not even justify the setting up of an hypothesis but the possibility deserves investigation.

We have seen from the foregoing that the quantitative aspect of development is dependent upon thyroid gland function. When this is lacking the extent and rate of development are not only retarded but become disproportionate and a different structural "type" of organism is produced within the species, the qualitative development of which apparently remains the same.

In view of these facts, it is not hard to believe that differences in thyroid gland activity play a significant role in the determination of some of the various human structural types. Circumstantial evidence leads us to believe that environmental influences are powerful factors in the determination of the level of thyroid gland activity. Diet, type of intestinal flora, and emotional contacts are apparently factors of importance. The direct effect of these acting through the thyroid on bodily structure during critical periods of development, complicates the estimation of the intensity of the factors of heredity in the determination of the adult structure. This is so because a disproportionate variation in development within a species may as well be due to an environmental influence changing the level of thyroid gland activity, as to a difference in the relative intensity of the inherited factors which determine the structural type of the species.

Social Conflict and Education

PURELY as a magnificent example of inductive reasoning, James Mickel Williams' *Principles of Social Psychology*[1] is admirable. The reader enjoys the mastery of scientific method, the induction of abstract conclusions from concrete examples, generalizations from particular cases.

But he inherent importance of examples and conclusions greatly surpasses their judicious use in a process of reasoning. The material Professor Williams so effectively uses forms the basis for a study of conflict in modern social organization. It is the author's purpose to analyze that conflict, looking into its causes, manifestations, and effects in the components of our present social structure.

The "psychology" of the study comes first of all in the analysis of the forces in individuals that cause conflict. These motives Professor Williams is pleased to group into several types of "dispositions" according to the predominance of one trait over others. The group includes the rivalrous, the dominating, the fearful, the sympathetic, the intellectual, dispositions. In modern phraseology Professor Williams characterizes human nature no less delightfully and aptly than the classical Greeks sketched types of men of olden days.

"Sociology" is joined with "psychology" in the exposition of these dispositions at work under the conditions of our social fabric. We see the conflict of interests in economic relations, in political relations, in professional relations, in family, cultural, educational relations, and the reactions of suppressed impulses on all these aspects of social organization.

This analysis is not always gratifying to our vanity. Another author might have made of the same material a caustic, repellent attack on social institutions. But Professor Williams'

(*Continued on Page* 322)

[1] WILLIAMS, JAMES MICKEL. *Principles of Social Psychology.* Pp. 400. Price $3.50. Alfred A. Knopf, New York, 1922.

HERITABLE CHARACTERS OF MAIZE

XV—Germless Seeds[1]

M. DEMEREC

Station for Experimental Evolution, Cold Spring Harbor, N. Y.

IN the winter of 1922 a peculiarity was noted on the germinal side of several seeds taken from a selfed ear. Closer observation revealed the fact that these seeds lacked the germ. The ratio of normal and germless seeds taken from the same ear indicated that the germless condition might be an inherited character. Further observations established this fact and gave the results presented below.

Description of Germless Seeds

As far as size and shape are concerned the germless seeds are normal or practically normal. When examined from the side opposite the germ in most cases they cannot be distinguished from normal seeds. When viewed from the germinal side the difference between the normal and germless seeds can be readily detected. The germinal area of a germless seed is without a sharp margin. It is more sunken than in a normal seed and is covered with wrinkled pericarp, which looks translucent because of air cavities below. If a germless seed is split vertically a cavity is found in the place where the germ is normally located. The difference between the normal and germless seeds can be seen from Figure 3.

When a seed with sugary endosperm is germless, the germinal area is still less distinct and in many cases the germinal and opposite sides can hardly be distinguished.

From the observed ratios it can be concluded that the germless condition is a result of the union of two gametes both of which are carrying necessary recessive factors. The fertilization is apparently accomplished and the development of the endosperm proceeds normally, but the development of the embryo is stopped in some early stage of its growth. Up to this time only mature seeds have been examined. In some of them only traces of an embryo could be detected; in others no signs of a developing embryo could be seen.

Inheritance of Germless Seeds

No special crosses were made for the study of the inheritance of germless seed. It was possible, however, to trace the behavior of the character through several generations, because it was found in several families grown for the genetical study of other characters.

A 63:1 Ratio—Three plants had been pollinated with the pollen from a Golden Bantam sweet corn plant, which was apparently heterozygous for germless. Part of the first generation ears grown from these crosses had all seeds normal, and the other part segregated into normal and germless, with the totals given in Table I.

A plant from family 311 was crossed with another plant from a different family which did not throw germless seed. Part of the second generation ears were normal and the other part segregated as shown in Table II.

The occurrence of 63:1, 15:1 and 3:1 ratios in the progenies of the crosses made by the pollen from a single plant and its progeny, indicates that in this case the homozygous condition of at least three genes was necessary for the expression of the germless character.

[1]Paper No. 111, Department of Plant Breeding, Cornell University, Ithaca, New York.

A 9:7 Ratio—A plant of the Bodwick variety grown from seed obtained from the Montana Experiment Station was crossed with another plant from a family grown for several years at Cornell for genetical studies. Both of these plants were selfed and both segregated for germless in a 3:1 ratio. The first generation from this cross had all seeds normal and the second segregated as shown in Table III.

The occurrence of a 9:7 ratio in the second generation shows that two independent factors for germless were present in this cross. The germless characters present in the parents were phenotypically alike, but genetically different.

Conclusions—From the data obtained it can be concluded that the germless phenotype may be expressed by several genetically different factors. The evidence presented shows that at least four different factors were present in the families discussed above. Three of them are triplicate genes and the fourth one, as far as it is known, acts as an independent factor.

Frequency of Germless Seeds Among Cultivated Varieties of Maize

Several commercial varieties of corn were recently included in the stocks grown for genetical studies, because they possessed some seedling characters of genetical interest. Progenies of those varieties which were selfed for two or three generations have been examined for the germless character. It was found that selfed progenies from about seventy-five per cent of the commercial varieties examined had some germless seeds. The ratio in which the germless character segregated was different in different varieties, as can be seen in Table IV.

Among inbred varieties grown at Cornell for breeding purposes, Professor R. G. Wiggans observed germless seeds in the following: Cornell II, Alvord's White Cap Yellow Dent, Onondaga White, and Latting's Red Cob White.

Summary

An inherited character called germless (*Gm gm*) is described. In germless seeds the endosperm is developed normally but the embryo is almost or entirely lacking.

The germless condition is recessive to normal. Segregations in 63:1, 15:1, 3:1 and 9:7 ratios were observed, which indicates the presence of at least four genetic factors for germless. Three of them are triplicate genes.

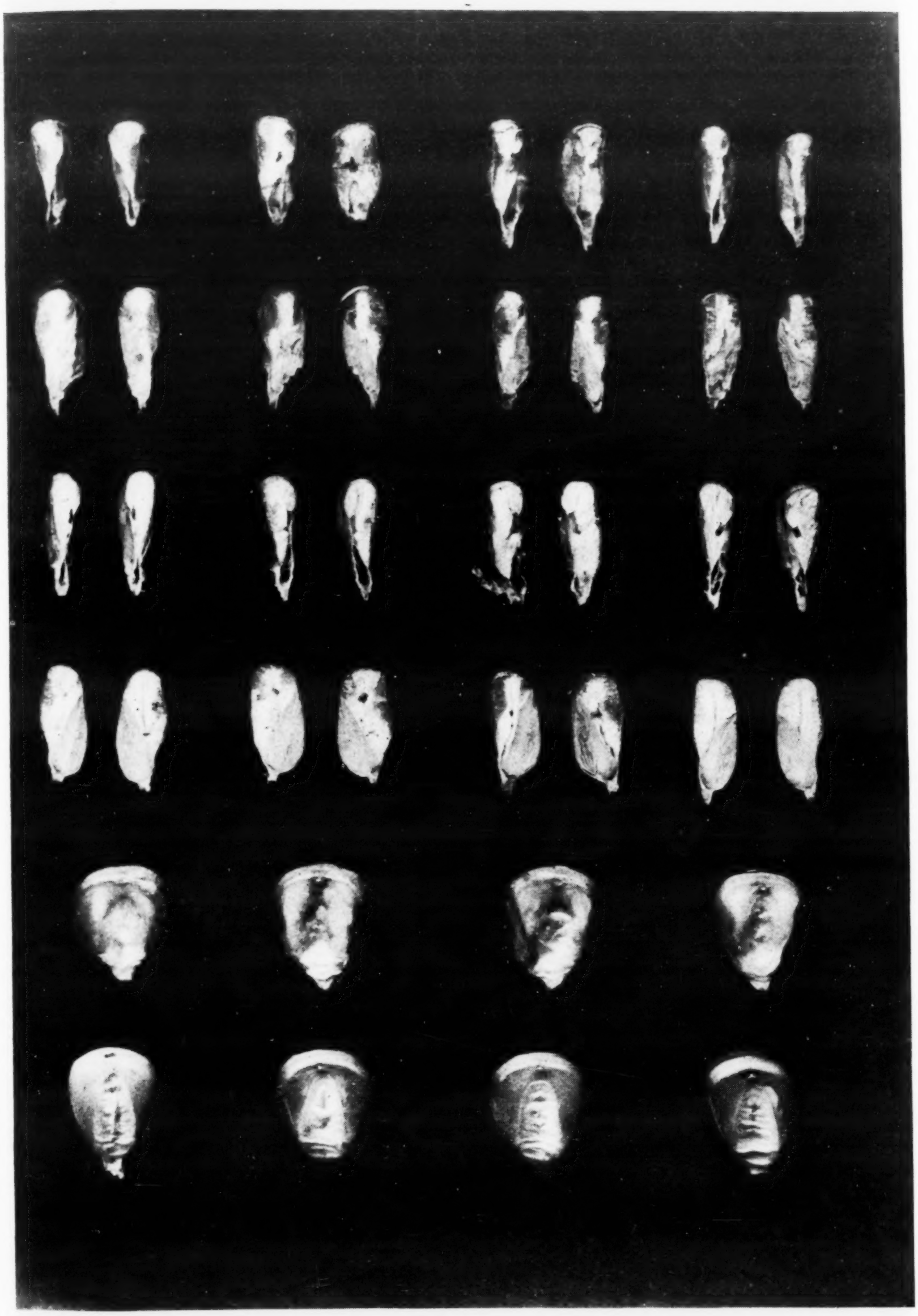
Germless seeds were found in the majority of commercial varieties of which selfed progenies were examined.

TABLE I—*Data regarding the segregation of ears for germless seeds in the first generation of certain crosses of Golden Bantam sweet corn.*

Family No.	Normal	Germless	Total	Ratio	Expected Germless	Difference
311	932	19	1055	63:1	16.4	2.6 ± 2.70
312	792	55	847	15:1	53.0	2.0 ± 4.46
313	142	2	146	63:1	2.2	.2 ± 1.01
313	35	2	37	15:1	2.3	.3 ± .99

TABLE II—*Segregation in second generation of heterozygous germless strain × normal.*

Family No.	Normal	Germless	Total	Ratio	Expected Germless	Difference
855	569	163	732	3:1	183	20 ± 7.9
855	679	44	723	15:1	45.2	1.2 ± 4.9



GERMLESS AND NORMAL SEEDS IN MAIZE

FIGURE 3. Alternate rows show germless and normal seeds, the second, fourth and sixth rows from the top being normal seeds; first, third and fifth rows, germless seeds. The upper four rows show longitudinal sections of the seeds through the embryo. The third and fourth rows show seeds that have been soaked in water for twenty-four hours. The first and second rows show dry seeds in section. Note the cavity in the germless seeds, and how little change has been produced in them by soaking as compared with the normal. Germless seeds have been observed in a number of variaties of maize, but the character is not inherited in the same way in all of them.

TABLE III—*Segregation in the second generation of a cross between two strains of maize heterozygous for germless seeds.*

Family No.	Normal	Germless	Total	Calculated Germless	Difference
			(3:1 Ratios)		
814-1	150	59	209		
-9	191	69	260		
Total	341	128	469	117.25	10.75 ± 6.32
			(9:7 Ratios)		
814-11	80	49	129		
-12	120	79	199		
Total	200	128	328	143.5	15.5 ± 6.08
			(All Seeds Normal)		
			814-8, -13, -15		

TABLE IV—*Ratios observed in segregation of germless seeds in commercial varieties of maize.*

Family No.	Name and Origin of the Variety	Ratios Observed
349	High Protein Strain from S. Dakota Exp. Sta...	15:1, 3:1
789	Low Ear Strain, S. Dakota Exp. Sta.....	63:1
787	Parson's Dry Land Corn, Montana Exp. Sta....	(71:15)
790	Wisconsin No. 10, Montana Exp. Sta.....	15:1
792	Fort Totten Indian Corn, Montana Exp. Sta.....	3:1
345	Bodwick, Montana Exp. Sta.	3:1
336	South American Corn, Dr. D. F. Jones.....	15:1, 3:1
333	Pseudo Starchy Corn, Dr. D. F. Jones.....	15:1
344	Early Canada Flint, Mr. Breck	15:1, 3:1
791	Pride of the North Yellow Dent, Isbell Seed Co., Jackson, Mich....	3:1
451	Dulton's Flint.....	63:1, 15:1
311-313	Golden Bantam.....	63:1, 15:1, 3:1
613	Luce's Favorite.....	15:1, 3:1

The Old American Stock

INCREASE OF POPULATION IN THE UNITED STATES 1910-1920: A study of changes in the population of divisions, states, counties, and rural and urban areas, and in sex, color, and nativity, at the fourteenth census, *by* WILLIAM S. ROSSITER. Census Monographs No. 1, pp. 255. Washington, D. C., 1922.

Information contained in many large volumes of the latest census has been condensed into this volume, intended for a more popular presentation of the facts. It will be almost indispensable to those interested in the population of this country, for it goes far beyond its title, and includes comparisons on many points as far back as the first census.

To a eugenist perhaps the most interesting feature are the calculations attemping to determine what part of the present population is descended from people who were living in the United States in 1790. Briefly, it is figured that perhaps 20,000,000 of the present inhabitants are of absolutely pure native white stock, while possibly twice as many more have a larger or smaller amount of the same "blood."

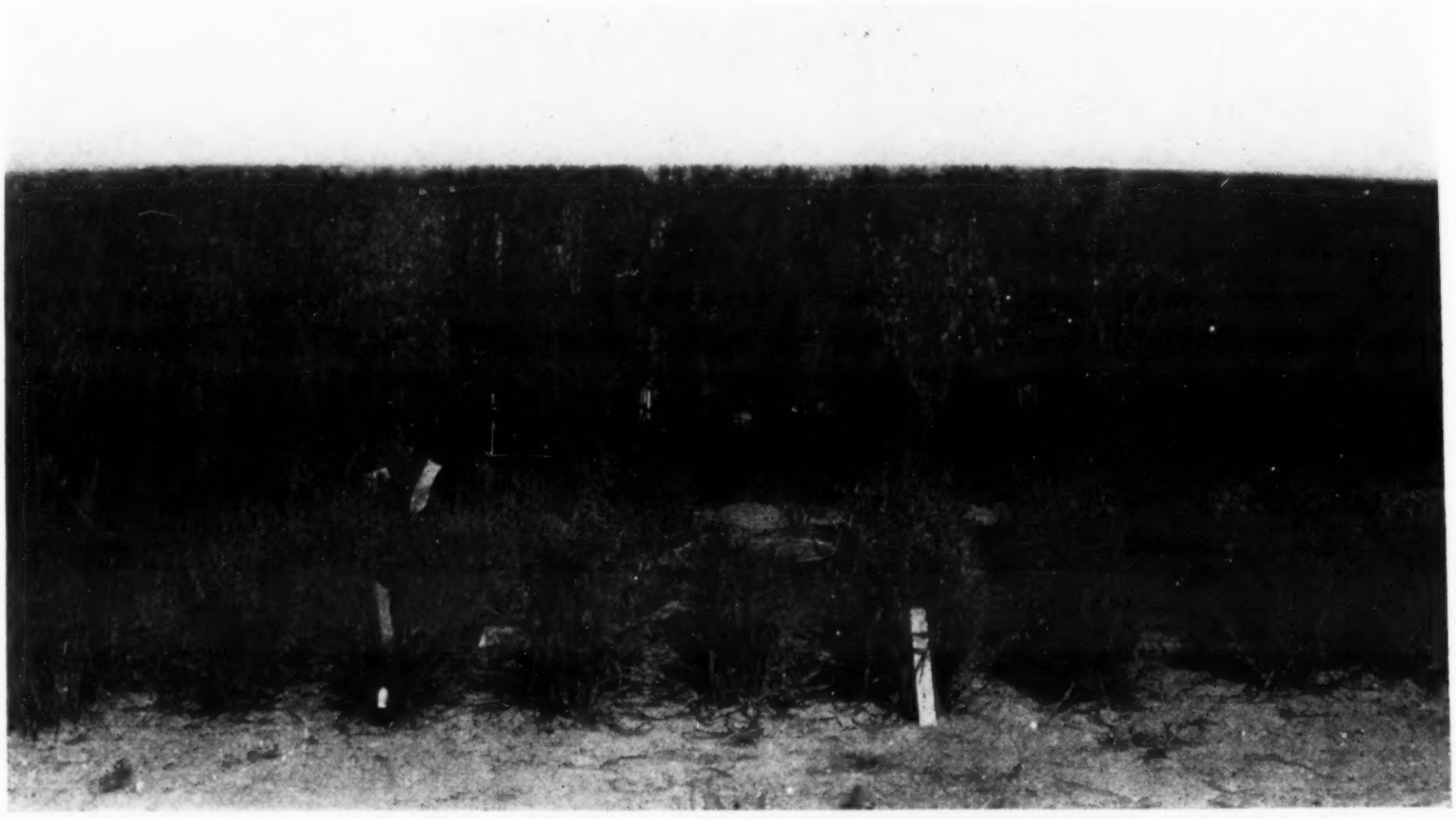
P. P.

PROLIFIC AND OTHER DWARF OATS

Dominant Dwarfness Observed in Two Oat Crosses

T. R. STANTON

U. S. Department of Agriculture, Washington, D. C.



DWARF OATS DOMINANT TO NORMAL

FIGURE 4. Progeny rows grown at Aberdeen, Idaho, in 1922 from eight prolific dwarf plants found in 1921 in a nursery row of the Aurora × Pringle Progress cross. Note the two normal tall plants in the fifth row from left. The dwarfs appeared in the sixth hybrid generation of the cross. It is possible that the two tall plants may have resulted from accidental admixture of seed. Further genetic studies of them and of the dwarfs would be necessary to determine this. If the tall plants prove to be the result of segregation it will mean that the dwarf character is dominant, which is exactly the reverse of what has been observed in other crosses with oats.

IN a nursery row of oats grown at the Aberdeen Substation, Aberdeen, Idaho, in 1921, eight plants of an early, prolific dwarf oat appeared. The plants in this row were grown from a selection of a cross between the Aurora and Pringle Progress varieties. This cross was made by the writer in the greenhouse at Arlington Experimental Farm, Rosslyn, Va., in the spring of 1916. Only one crossbred seed was obtained. This was sown in the greenhouse in the fall of 1916, and produced a vigorous plant. Seed from this plant was sown in a five-foot row at Aberdeen in the spring of 1917 and produced nineteen second generation plants. These were harvested individually and sent to Washington by C. W. Warburton, then agronomist in charge of oat investigations. In the spring of 1918 seed from each second generation plant was sown at Aberdeen in individual five-foot rows, producing at harvest approximately 500 third generation plants. Of the nineteen progenies nine were considered as being homozygous, and were harvested in bulk Among these nine, No. 1019 a1-12B was included, in which

the dwarfs appeared in 1921. Of the remaining ten, five were discarded and further selections were made from the others. These third generation progenies, including the nine bulked strains and the reselections, again were grown in five-foot rows at Aberdeen in 1919. In 1920 the strain 1019 a1-12B, along with twenty-four others of this cross, were advanced to the rod-row nursery at Aberdeen. At harvest time these rows were cut in the usual manner, but no dwarfs were noted in the row of 1019 a1-12B. In 1921 these same strains were once more included in the rod-row nursery at Aberdeen, and at harvest the eight dwarf plants were observed in the row of selection 1019 a1-12B, the dwarfs thus appearing in the sixth hybrid generation of the cross.

Progeny of the Dwarf Plants

The eight dwarf plants were harvested individually and sown in five-foot rows at Aberdeen in the spring of 1922. The eight plants bred true for dwarfness, with the exception of one row, in which two tall plants appeared. It is possible that these two plants were accidental mixtures and not plant segregates. One was yellow-seeded like the Aurora parent, and the second was black-seeded unlike the other parent, Pringle Progress, which is a white oat. To determine the genotypic make-up of the two tall plants, individual progenies from them will be grown in 1923, as well as from the dwarfs in this row. The eight dwarf mother plants produced about 230 dwarf plants.

One of the most interesting things about this dwarf is its prolificacy. Practically every culm produced a small panicle with numerous spikelets. The plants were distinctly turf-like, in which character they were similar to the dwarfs from Victory oats, described by Warburton.[1] However, in earliness and prolificacy it is distinct from the Victory dwarf. This new dwarf is quite early and produces fully ripened grain in abundance, while the Victory dwarf is very late and barely ripens sufficient seed to reproduce itself. The prolificacy of the dwarf plants grown at Aberdeen in 1922 is shown in Figure 4.

The genotypic composition of the dwarf form has not been determined by crossing it with the normal tall, but it is possible that it will behave as a pure recessive, as was the case in the dwarf reported by Warburton. The fact that it was not found until the sixth hybrid generation may be due to its having been masked in some unknown manner, becoming apparent only after proper recombination of factors had occurred. On the other hand, if the two tall plants appearing in the progeny of the one dwarf plant are the result of segregation a condition directly the reverse of that shown by Warburton is evident, that is, the tall character must be considered as recessive and the dwarf character as dominant. It also is possible that the dwarfs may be mutations, or that they may be due to some combination that is not simple in nature. That the condition is complex is evidenced by the dwarfs not appearing in generations earlier than the sixth.

Dwarfness in Other Hybrids

In 1921, dwarf oats also appeared at Aberdeen in the progeny of another cross. The plant material in which this dwarf appeared represented the fourth generation progeny of a cross between Winter Turf and Sixty-Day. In all, eight progenies of this cross were grown in plant rows at Aberdeen in 1921, which represented plant selections from third generation material. Of these eight progenies, three produced one dwarf plant each. The number of dwarf and tall plants produced in the three segregating rows in 1921 is shown in Table 1.

[1] Warburton, C. W. The Occurrence of Dwarfness in Oats. *Jourl. Amer. Soc. Agron.*, xi:72-76. 1919.

ANOTHER CASE OF DOMINANT DWARFNESS IN OATS

FIGURE 5. Progeny of one of the mother-dwarfs from the Winter Turf × Sixty-Day cross. Note the normal (tall) segregates in row with dwarfs. Rows in foreground were cut away to show dwarfs. The evidence that the dwarf character in this cross is dominant is more conclusive than in the case of the prolific dwarf (Figure 4).

In 1922, progenies from the three dwarf and nineteen of the fifty-two tall plants were grown in individual five-foot rows at Aberdeen. The nineteen tall plants from selection 1009 b2-20-3-5 produced approximately 450 tall plants and no dwarfs, thus showing a homozygous condition for the tall character. Seed of the tall plants from the other two dwarf-producing progenies of 1921 was not sown individually in 1922, but in bulk. One panicle was taken from each plant, thus making a composite sample of seed. From this seed approximately 200 plants each from selection 1009 b2-20-3-6 and 1009 b2-20-3-7 were grown in 1922. These rows were carefully inspected but no dwarfs were found.

As to the behavior of the progenies of the dwarfs, the number of tall and dwarf plants produced by each is shown in Table 2.

According to the data shown in Table 2, the three dwarf plants produced in 1921 were heterozygous. They produced a progeny of seventy-five dwarf and twenty-two tall plants, thus showing an approximate ratio of three to one. The interesting feature in this connection is that the dwarfs are heterozygous, rather than the tall plants, indicating a condition similar to

that possibly existing in the prolific dwarf previously described, provided the tall plants appearing in the progeny of the one plant were the result of a recombination of certain factors instead of accidental admixtures. These data indicate that the dwarf character is dominant, and the tall character recessive. This condition, therefore, is directly the reverse to that shown by Warburton in the dwarf plants from Victory.

The three mother-dwarf plants produced in 1921 as well as the seventy-five grown in 1922 were decidedly late in maturity and not very prolific. The progeny of one of the dwarf plants is shown in Figure 5. In most characters they resemble very closely the dwarfs described by Warburton.

Discussion of Results

Assuming that the two tall plants appearing in the relatively large dwarf progeny from the Aurora X Pringle Progress cross were accidental mixtures, and that the dwarf character in this cross behaves as a pure recessive, there still remains some explanation to be made of the directly reversed behavior shown in the progeny of the dwarf plants from the Winter Turf X Sixty-Day cross. One explanation for the appearance of the apparently heterozygous dwarf is that it arose as a result of a mutation affecting either the pollen or egg cells of a normal plant and resulting in the genotypic make-up D^d d^d, for the dwarf, assuming that D denotes the presence of the factor for dwarfness. In the next generation this would produce the following:

1	D^d D^d	
2	D^d d^d	Dwarfs 3
1	d^d d^d	Normal 1

thus giving a simple Mendelian monohybrid ratio of three dwarfs to one tall, as indicated by the data in Table 2. The origin of the heterozygous dwarf possibly is not so simple as the above explanation would indicate.

In order to obtain additional data on the behavior of this dwarf, individual progenies of all plants producing seed from the three segregating rows will be grown in 1923. The segregates homozygous for dwarfness will thus be determined. These then will be back-crossed on the homozygous talls in an attempt to determine the various factors involved in the production of the heterozygous dwarf.

Miyazawa[2] very recently has reported similar hereditary behavior of a dwarf form of barley in which the dwarf character is dominant and the dwarf plants are heterozygous, a pure dwarf condition apparently being lethal. He obtained a ratio of approximately two dwarfs to one normal, instead of a ratio of three to one, from which he concluded that typical segregation was not shown. In further investigations with this dwarf he discovered among his seedlings a new dwarf form (a sterile dwarf) which tillered freely, but grew very slowly and produced no seed, the length of the culm being markedly shorter than that of the original or non-sterile dwarf. Of 684 plants grown he classed 156 as sterile dwarfs, 340 as non-sterile dwarfs, and 188 as normal, the ratio of the three types thus being approximately 1:2:1. The original dwarf found in 1915 was described as being intermediate externally, that is, shorter than normal, but taller than the sterile dwarf. Theoretically he concludes that if the allelomorph for dwarfness and absence of dwarfness is denoted by D and d, respectively, the sterile dwarf = DD, the normal =dd, and the ordinary dwarf = Dd. On the basis of this explanation he suggests that the seed which first produced the dwarf plant, Dd, may have arisen from dd by mutation.

[2] Miyazawa, Bungo. Hereditary Behavior of a Dwarf Form of Barley in Japan: *Jourl. Genetics,* xi:205-208; 1 plate, Cambridge, Dec. 1921.

TABLE 1. *Number of tall and dwarf plants obtained from the three segregating rows of the Winter Turf X Sixty-Day cross, grown at Aberdeen, Idaho, in* 1921.

Row No. 1921	*Hybrid No.*	*Number of Plants*	
		Tall	*Dwarf*
897	1009 b2-20-3-5	19	1
898	1009 b2-20-3-6	16	1
899	1009 b2-20-3-7	17	1
	Total	52	3

TABLE 2. *Segregation of the three dwarf plants from a cross between Winter Turf and Sixty-Day oats grown in plant rows at Aberdeen, Idaho, in* 1922.

Row No. 1922	*Hybrid No.*	*Number of Plants*	
		Tall	*Dwarf*
486 and 487	1009 b2-20-3-5	7	36 ....
507 and 508	1009 b2-20-3-6	11	22
517	1009 b2-20-3-7	4	17
	Total	22	75
	Approximate ratio	1	3

A New Edition of "The Livestock of Great Britain"

FARM LIVESTOCK OF GREAT BRITAIN, *by* ROBERT WALLACE, assisted by J. A. SCOTT WATSON. Fifth edition. Oliver and Boyd, Edinburgh, Tweeddale Court. 1923.

Since the first edition of Professor Wallace's book appeared in 1885 it has been recognized as the standard work on its subject. The fifth edition has just been issued. It has been revised and considerably enlarged with the assistance of Professor J. A. Scott Watson, Mr. Wallace's successor as Professor of Agriculture and Rural Economy in the University of Edinburgh.

The first chapter presents a condensed but sound discussion of the modern theory of heredity and its application to livestock breeding. The greater portion of the 868 pages are devoted to the discussion of the origin, development and present characteristics of the British breeds of livestock. An enormous body of facts are presented in thoroughly readable style. Chapters in the book deal with the management of the various kinds of livestock and with their diseases and with the home or first aid treatment of these.

One of the most valuable features of the work is the abundance of excellent illustrations, 442 plates and 111 text figures. We find, for example, no less than 28 photographs of Shorthorn cattle admirably chosen to illustrate the various types, Scotch, Booth, Bates, milking type, etc. These photographs and those of the other breeds will repay hours of study. Altogether the book is one which should be familiar to all who are interested in the improvement of livestock.

S. W.

A HANDBOOK OF HUMAN BIOLOGY

A Review

HUMANISTS often are jealous of the pigs, calves or cabbages in the belief that more careful, scientific study has been given to the plants and animals than to the human breed, and that more definite information is available upon the proper handling of crops and herds than upon the nurture and education of children. This feeling will not be allayed by a reading of the present work,[1] but progress is made through every recognition of the need of developing the human side of biology, and the present effort to supply this enormous deficiency should be highly appreciated. The result is a notable achievement that must find a place in all working libraries that include general biology and the social sciences.

People are more important than plants and animals, and partly for that reason are much more difficult to study scientifically, because regular experimental methods are not applicable to normal human populations, rarely even to a few individuals. Hence the biological data of humanity are restricted largely to observation and inference, which are much more difficult to make and to interpret correctly than to secure corresponding experimental data from other species that can be placed under controlled conditions. From any agricultural standpoint the human crop must be reckoned as a failure if we consider how few of our young men and women attain, or even approach, the full standard of their possibilities of development. We are becoming conscious of the limitations of our educational system but lack the knowledge and understanding that are necessary to devise practical ways to change it.

As it is necessary to go outside civilization and live with savages in order to begin properly to appreciate civilization, and to understand what civilization is, so it is necessary to go outside of man to the life of animals and plants, in order to see more clearly what is peculiar to man, and thus to gain a more practical consciousness of human development, racial and individual. Most of the animals and plants are easily found and studied in the wild state, so that we may know their original habits and the conditions and the limiting factors of their development, but we have only fragmentary data and slight understanding of the biology of primitive man.

Though our author has little to say directly of eugenics, which consciously has figured very little in the past of human development, the eugenic position is powerfully supported by a world-wide collection of facts relating to human existence, and showing that in one form or another, natural, political, economic, social or religious, there have been selective checks to reproduction, working through all the ages and stages of human progress, and tending in direct or different ways to strengthen or to weaken the tendencies of human development. What we begin to see as we become more conscious of the sorting processes of the present age, is that civilization may suspend or reverse the conditions of natural selection that tended always to the further improvement of the race, and establish forms of negative or adverse selection. If special ability and higher education do not have greater survival value, so that the capable are more likely to marry and to raise larger families than less capable and less educated people, a condition of negative selection must

[1] CARR-SAUNDERS, A. M. *The Population Problem; a Study in Human Evolution.* Pp. 516. The Oxford University Press, New York, and London, 1922.

be admitted as evidence that our present system is unbiological and self-destructive.

Since eugenics as a practical investigation needs to begin with a conscious and constructive recognition of the biological forces that have been active in the past, and have brought us where we are, such a survey of the data of human development is a fundamental contribution to eugenics. Though the standpoint of the present work might be described as Malthusian, in the sense of reckoning human fecundity as normally in excess, and often outrunning the economic development of primitive peoples, this has no relation to the birth control vagaries of Malthusianism. That some of these notions have had the support of John Stuart Mill and other well-known names only shows the greater need of scientific recognition and study of the population factors.

Following a critical historical review of previous studies of population, data are assembled from many fields of inquiry, anthropology, ethnology, psychology, pathology, history, politics, and education. Conditions of primitive and prehistoric life are considered for fishing and hunting tribes, and for early agricultural stages, contrasting with urban and industrial conditions of the historical periods, ancient, mediaeval, and modern. How fecundity is restricted and regulated among primitive peoples by the conditions of existence and by mental habits, social customs and religious beliefs, all working automatically and unconsciously as checks on population, is outlined and documented to an extent that can leave no doubt of the vast importance in former times of many factors of selective elimination.

That most of these primitive selective factors have become almost entirely ineffective in the present state of civilization, but have not been replaced by any other system for maintaining the quality of the human organism, is a most disquieting aspect of human biology. Though it may be doubted or denied that selection is strictly and properly considered as a cause of evolution, there is no such doubt or denial of the power of negative selection, to weaken or destroy any special character or ability that for any reason is excluded from reproduction. If the effect of civilization is to preserve the weak and incapable while the strong and able stocks are consumed in leadership or otherwise excluded from reproduction, the quality of the race must decline, so that the decay of civilization can be reduced to a simple biological formula of negative selection. This is going somewhat beyond our author, though not out of line with his argument.

Later chapters of the book are especially needed by those extreme eugenists whose zeal for germinal improvement leads to a disregard of the environmental and educational factors of development. The last three chapters, on "tradition" are very valuable in their clear recognition of what so many writers on history and education leave out of account, that the "tradition" or carry-over of experience and opinion from each generation to the next is the chief factor in developing or maintaining civilization. Our author does not seem to see as clearly as he might that the problem of "tradition" is the problem of education, or that an over-developed institutional system of education is not an adequate vehicle for "tradition," but tends rather to separate and reduce the contacts between the generations.

The peculiar relation of agricultural life to the development of civilization in providing the full contacts between the generations that are necessary for developing and maintaining civilizations are also not recognized with sufficient clearness, though the treatment of Payne's "History of the New World Called America," is followed in trying to place history on an agricultural basis. Even Payne's mistake of supposing that rice originated in America figures in the discussion of primitive agricultural conditions in America.

Many special features of the work

would be of interest from the standpoint of current discussions, but a single example must suffice. A complete negative is given to an idea frequently indulged by writers on the oriental problem, that a solution may be found in emigration, to relieve the pressure of population. This belief appears altogether unwarranted when account is taken of the rapid rate of increase that must be expected and the very brief period that would be required to fill up Japan or China, or the whole of Asia, and the other continents as well.

EUGENICAL STERILIZATION

A Review

ORGANIZED interest in eugenics in the United States goes back little more than twenty years. As an outgrowth of the activity started by the rediscovery of Mendel's Laws, the American Breeders' Association was organized in 1905 (its name being changed in 1913 to American Genetic Association); and in the following year it created a committee on eugenics, which a few years later was elevated to the position of a section.

Even before this—namely, in the first part of 1905—the Pennsylvania Legislature had passed the first sterilization law, and thus started a movement which has ever since been, in the minds of some people, largely synonymous with eugenics.

The Pennsylvania bill was vetoed in an ignorant and facetious message from Gov. Samuel W. Pennybacker; but two years later Indiana adopted a similar measure which was put into effect.

In 1911 the eugenics section of this association formed a committee "to study and report on the best practical means for cutting off the defective germ-plasm in the American population." The late Bleecker Van Wagenen was chairman of this committee; H. H. Laughlin, superintendent of the Eugenics Record Office at Cold Spring Harbor, Long Island, as secretary of the committee immediately began a study of the subject,[1] which he has continued for the past twelve years, until the body of material he has accumulated has been published,[2] in the form of a report of the psychopathic laboratory of the municipal court of Chicago. It forms by far the most complete and factual study of the subject that has been made, and must stand for a long time as the standard work of reference in this field.

Meanwhile, fifteen states have adopted sterilization laws at one time or another, and in a dozen of these states, operations, to the total number of 3,233 (data as of Jan. 1, 1921) have been performed. Dr. Laughlin summarizes the status of the laws as follows:

> Among the 15 states which have enacted eugenical sterilization statutes the law is still on the statute books, unattacked by the courts and therefore available for use, in the following nine states: California, Connecticut, Iowa, Kansas, Nebraska, North Dakota, South Dakota, Washington, and Wisconsin. California, Connecticut, Kansas, Iowa, and

[1] A preliminary report was made by Mr. Van Wagenen at the First International Congress of Eugenics (London, 1912); a second report was published in two bulletins of the Eugenics Record Office in February, 1914: "The Scope of the Committee's Work" (Bulletin 10-a), and "The Legal, Legislative and Administrative Aspects of Sterilization" (Bulletin 10-b), both written by Dr. Laughlin.

[2] EUGENICAL STERILIZATION IN THE UNITED STATES, by HARRY HAMILTON LAUGHLIN, D. Sc. Pp. 502. Published by the Psychopathic Laboratory of the Municipal Court of Chicago, December, 1922.

Washington, have each enacted more than one eugenical sterilization statute.

In California and Nebraska the law is functioning in a very satisfactory manner. In Connecticut, North Dakota, and Wisconsin, similarly, the law is being applied in a satisfactory manner, but to a very limited extent. In Washington and Nebraska special executive machinery of proved competency is entrusted with the enforcement of the sterilization law. In Kansas and Iowa it has fallen into disuse. In South Dakota the statute is practically a dead letter.

In Iowa the law of 1913 was declared unconstitutional; it was repealed and re-enacted in new and, apparently, constitutional form, in 1915. In New York the law was declared unconstitutional by the courts (1918) and repealed (1920), but has not yet been re-enacted by the legislature. In New Jersey, Nevada, Michigan, Indiana, and Oregon, the laws were declared unconstitutional by the courts but are still on the statute books, dead letters. In the state of Washington litigation resulted in upholding the constitutionality of a very drastic eugenical and punitive sterilization law.

Eugenical sterilization laws have been vetoed by the governors of Pennsylvania (1905, 1921), Oregon (1909), Vermont (1913), Nebraska (1913), and Idaho (1919), subsequently, however, Oregon (1917) and Nebraska (1915) enacted successful laws. In Oregon, also, a former sterilization law was revoked (1913) by referendum.

Under the law thus far there have been eugenical sterilizations in only state institutions for (1) the insane, (2) feebleminded, and (3) criminalistic. No eugenical sterilization operations have thus far been performed in—

(a) State institutions for the (1) inebriates, (2) diseased, (3) blind, (4) deaf, (5) deformed, (6) dependent, (7) epileptic, nor in

(b) County, municipal, or private institutions for any type of the socially inadequate, nor

(c) Among the socially inadequate and cacogenic individuals in the population at large.

Analyzing the data from another point of view, there have been altogether 124 state institutions legally authorized to perform sterilization operations, or which 31 have made more or less use of their authority, while 93 have not. At the present time (i. e., Jan. 1, 1921) there are 70 state institutions legally entitled to the practice. The number of operations performed, by classes, is:

Feebleminded	403
Insane	2,700
Criminalistic	130
Total	3,233

By states, the operations are divided as follows:

California	2,558
Connecticut	27
Indiana	120
Iowa	49
Kansas	54
Michigan	1
Nebraska	155
Nevada	0
New Jersey	0
New York	42
North Dakota	23
Oregon	127
South Dakota	0
Washington	1
Wisconsin	76
Total	3,233

It thus appears that a single state is responsible for the great bulk of the operations listed; and in this state a single institution (the state hospital for the insane at Patton) is responsible for 1,009 cases.

Dr. Laughlin publishes the texts of all the laws, past or present; the veto messages where such action was taken; the briefs and decisions in all litigation on the subject; opinions by attorneys-general and others; together with a handy analysis of all this material. He also presents his idea of a model sterilization law, with the necessary forms for putting it into effect.

A chapter of eleven pages is devoted to a review of evidence and testimony (mostly the latter) as to the physiological and mental effects of sexual sterilization. Unfortunately, no satisfactory evidence is presented on one of the most important phases of the whole subject, namely, the supposition that the release of sterilized individuals with feeble inhibitions or anti-social tendencies is simply equivalent to the creation of so many new and virulent

foci of dissemination of venereal diseases and promiscuity.

Many collateral data of interest are recorded, such as a list (with bibliographical references) of all the traits in man which have been shown or supposed by one or another investigator to be hereditary; a list of institutions and organizations particularly concerned with eugenics; and tables showing the probable results of different types of mating.

Dr. Laughlin's analysis of the state laws now in force shows that none of them is free from defects, and some of them are definitely bad from the point of view of the biologist. He believes that the right of the state to pass and enforce a eugenical sterilization law is pretty certain; it is not so much now a question of constitutionality as a question of policy. It is probably a fair deduction from the facts he presents, that eugenical sterilization laws are gradually losing interest for the public, and to some extent at least for professed eugenists. They may have legitimate application in certain directions, as among the insane, but for the most part it has come to be recognized that persons of a markedly defective type ought to have life-long custody with separation of the sexes,—that it is not fair either to them or to to society to set them free, sterilized or not, and expect them to hold their own with the normal members of society. But if they are thus in custody, sterilization is quite unnecessary because useless.

—Paul Popenoe.

Female Pure-Bred Livestock Shows Rapid Increase

When farmers adopt pure-bred sires to head their herds and flocks it is not long before the percentage of pure-bred females increases notably. This encouraging tendency toward more rapid improvement of live stock has been brought out by the United States Department of Agriculture in the "Better Sires—Better Live Stock" campaign.

Of a total of more than 200,000 female animals listed by farmers who have agreed to keep nothing but pure-bred sires, more than 35 per cent are of pure breeding. On these farms scrubs have practically disappeared. For the larger animals the reports show that only 2.4 per cent of the females are scrubs and, of course, the males are of pure blood, as that is the basis on which the farms are listed.

The poultry flocks owned by these farmers are particularly well bred, only 1.3 per cent of the female birds being listed as scrubs. More than 68 per cent of a total of 610,000 birds are entered on the list as standard bred. Among the herds of swine there are very few scrub sows—only 1.1 per cent. Nearly two-thirds of them are pure bred.

This Federal-State effort to improve the live stock and poultry of the country has now brought in a membership campaign that represents nearly a million head of animals and poultry. Farmers who have become members have sent in interesting accounts of their experiences in improving their animals and their bank accounts Other farmers who are taking part in the work are invited by the department to send in their individual experiences as well as those of community organizations engaged in the improvement of live stock. Definite facts and figures should be included whenever possible.—*U. S. Department of Agriculture.*

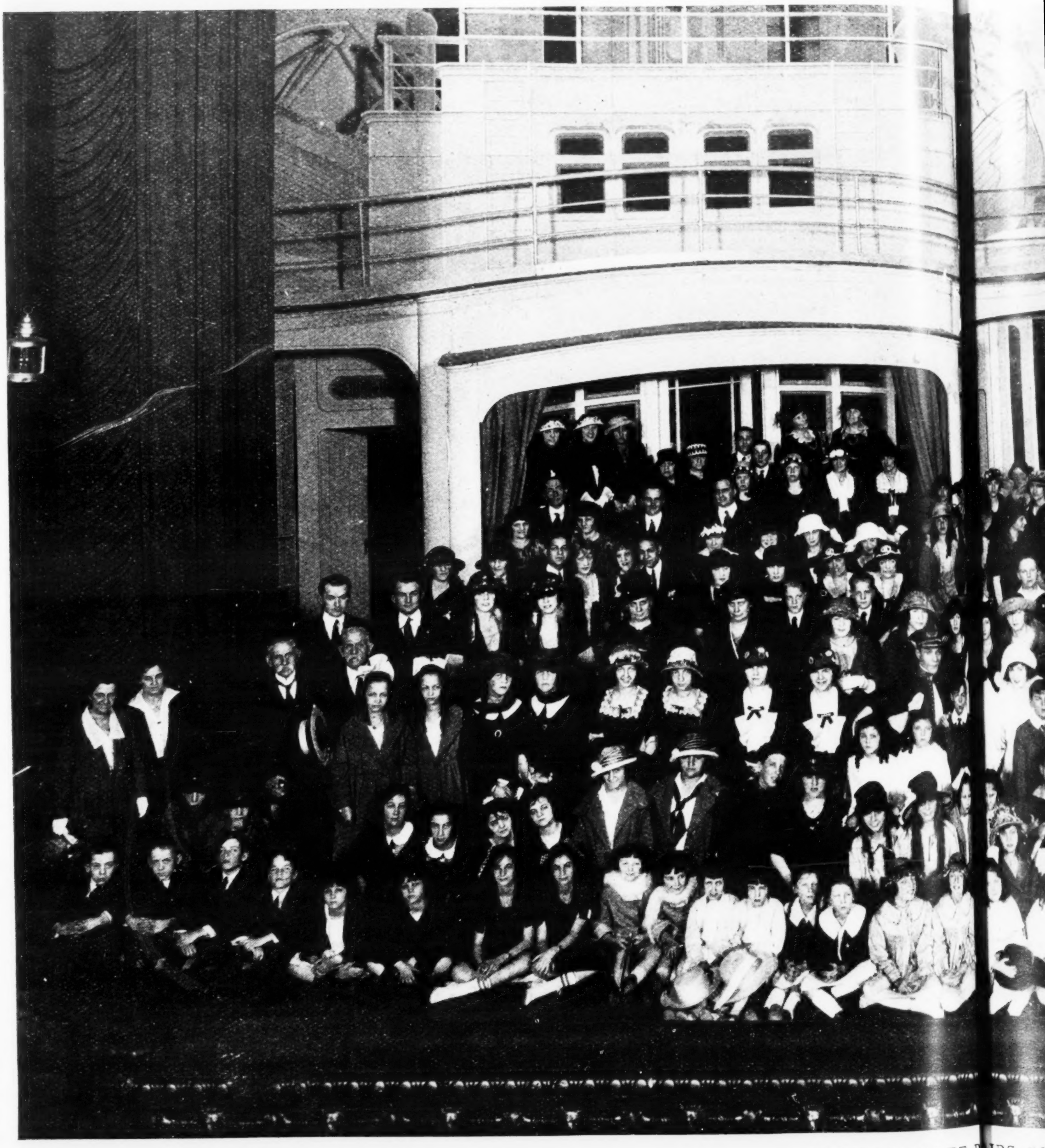
TWINS AGAIN

ALBERT EDWARD WIGGAM
New York City

IDENTICAL AND UNLIKE TWINS

FIGURE 6. Leopold Klein and his twin brother, eighty-seven years old, have been dissimilar throughout their lives, although reared and still living under very similar conditions. The Fairbanks twins, Broadway stars, are seated between the Klein brothers. Their mental similarity is so great that they were constantly accused of copying each other's work when in school. The Austin twins (lower left) are very close duplicates, patches of freckles below their eyes being almost indistinguishable in pattern. The other girls are also identical twins, but their pose does not show their similarity so well.

TWINS are of perennial interest, both popular and scientific. The writer recently sent out a request for twins through one of the popular magazines, and received portraits of more than one hundred pairs, with numerous interesting details about many of them. While the data by themselves would not enable us to arrive at any definite conclusion, yet they are entirely in harmony with all previous studies and emphasize the fact that the nearer we approach in identity of physical organization, the nearer we seem to approach in mental traits. For instance, the writer and his wife found that by first inspecting the photographs sent in and estimating the relative resemblances in physical appearance, we could make a pretty



NINETY-THREE PAIRS OF

FIGURE 7. A "Twin Matinee" was given in honor of the Fairbanks twins, stars in "Two Little ... as well as several ... invited free of charge, and ninety-three pairs of those who accepted the invitation, ... taneously by the identical pairs.

REE PAIRS OF TWINS

in "Two Little Girls in Blue," at the Cohen Theater in New York, May 18, 1921. Twins were s well as several odd twins, are shown here. Note similarity of the positions assumed spon-

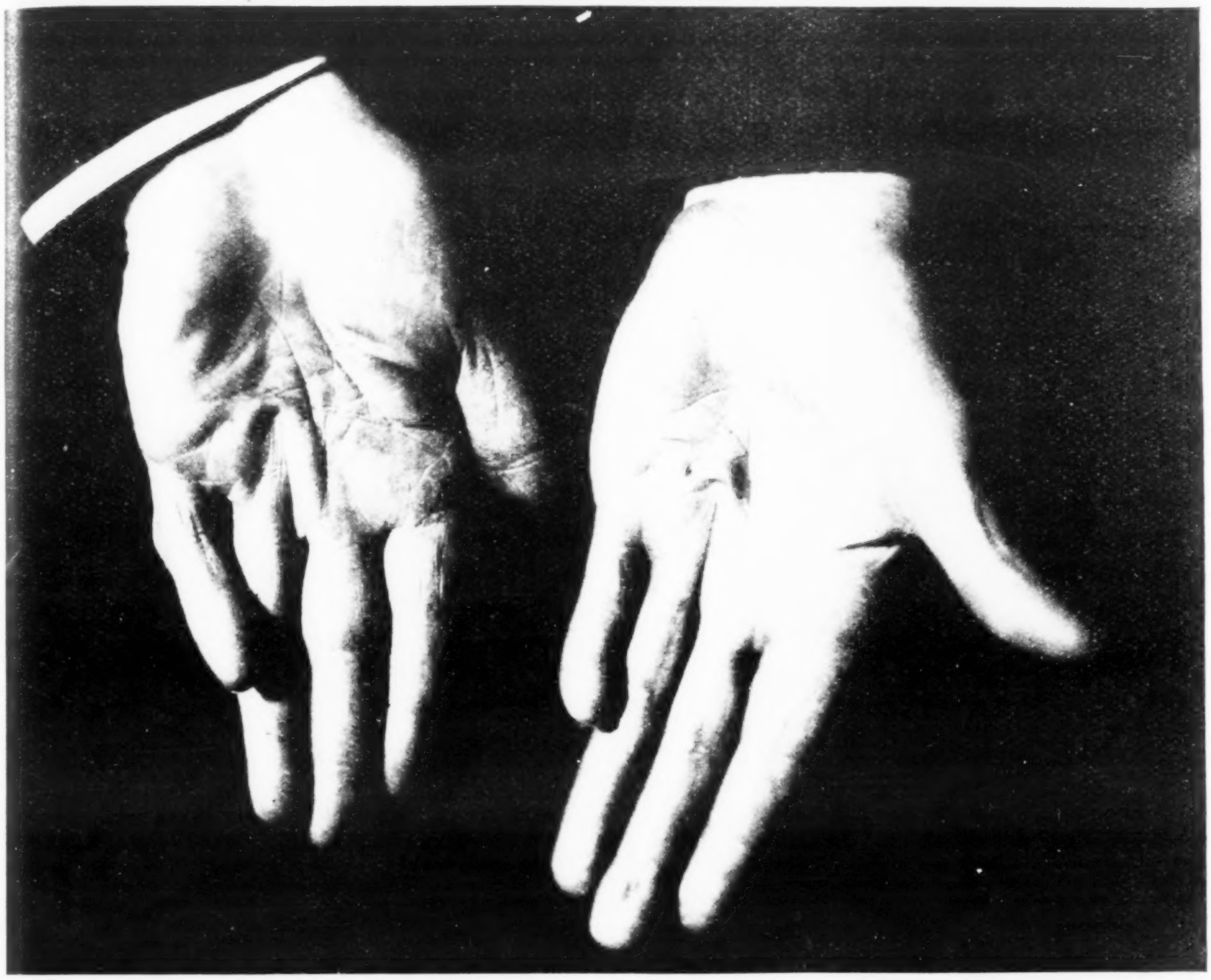
THE FARMER TWINS

FIGURE 8. The Farmer twins are contracting masons in New York City. They state that they were born with the fingers interlocked as shown in the photograph. Possibly this has some connection with the peculiar marks in the palms of their left hands (see Figure 9). Their workmen are not able to tell which twin is directing them, and their voices can only be distinguished with difficulty. At seventy-eight their physical condition and energy is extremely similar.

close guess as to what the informants would relate in their letters as to their mental and temperamental resemblances. In reading many of the letters one could scarcely help believing he was merely reading over again Galton's letters from twins written nearly half a century ago.

Ninety-three Pairs of Twins

During this work a musical comedy on Broadway, "Two Little Girls in Blue," advertised a "twin matinee" in honor of the Fairbanks twins, two young ladies, stars in the play, and the Tomson twins, two young men singers of the cast, at which "all twins in New York" were invited free of charge. Such an array of duplicated human beings probably never before was assembled. The writer, a twin, sat where he could observe the audience. To see faces apparently identical, scattered in pairs all over the auditorium, moving, laughing or sitting at attention in what appeared to

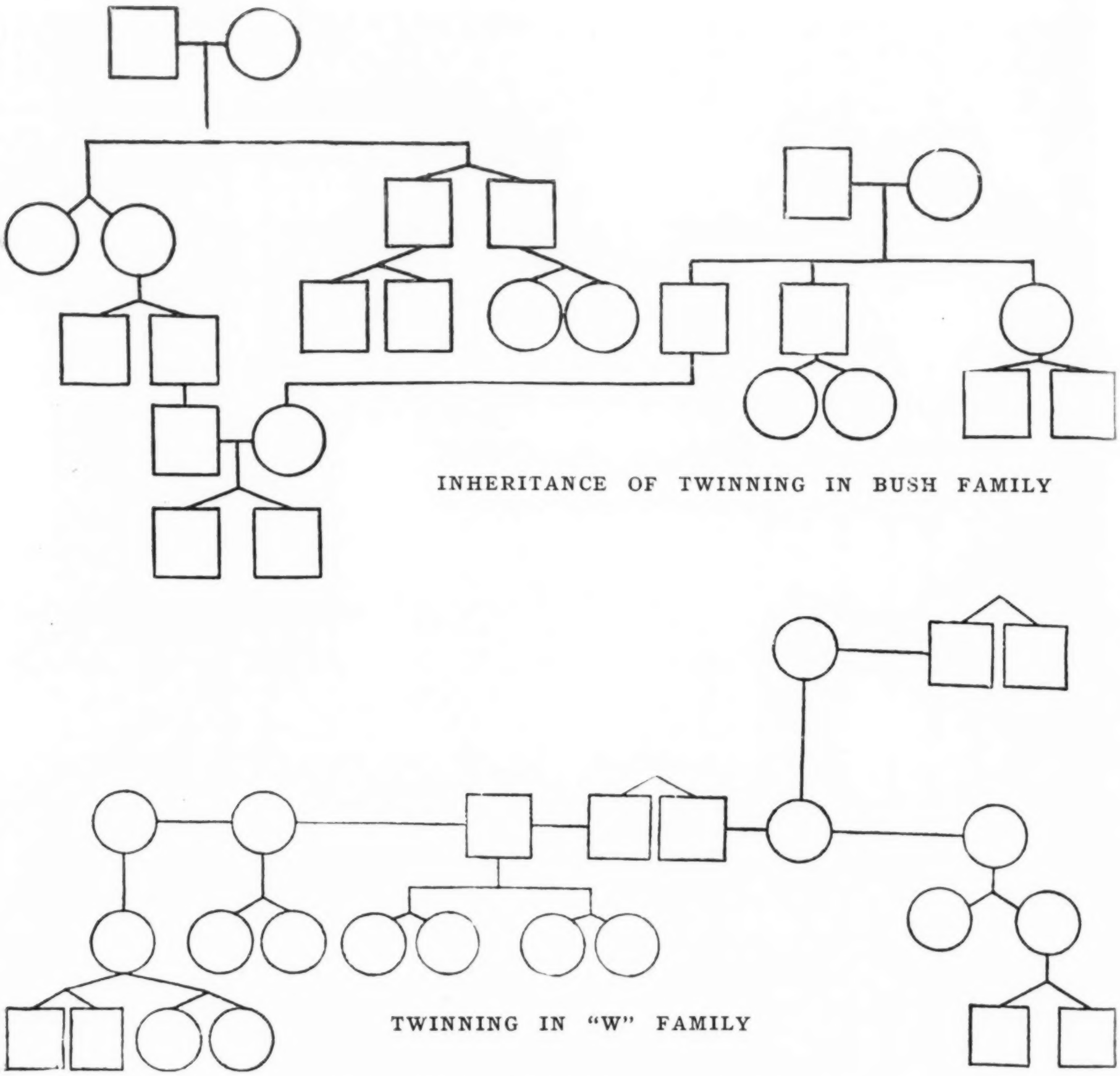


PECULIAR ABNORMALITY IN HANDS OF FARMER TWINS

FIGURE 9. This unusual "corrugation" was present at birth, and after more than half a century of handling mason's tools and rough stones these marks are still as well defined as ever, and still nearly as similar as at birth. Note the characteristic position of the little fingers, and the similarity of the lines in the palms of the hands.

be precisely the same attitudes, laughing in the same key, their faces furrowed and wrinkled in the same lines at every expression of emotion, was a unique experience. Ninety-three pairs and one or two odd ones were photographed in a group at the close of the performance. As will be noticed in the photograph, the "identical" twins are mainly disposed spontaneously in similar attitudes, while those who are plainly unlike stand or sit differently. The twins ranged in ages from seven years up to eighty-seven, the latter, the Klein brothers, unlike twins, of Brooklyn, receiving a gold medal as the oldest twins present. They informed the writer that they had always lived very much together but "were not much like each other."

The same thing came out in this study that has appeared in all studies, especially that of the JOURNAL OF HEREDITY, that the more alike twins are, the more interest they take in each other. Over three-fourths of my correspondents were very much alike. At this twin matinee, nearly all of the pairs were of the similar type. Omaha, Nebraska, reports a "Twin Club" of fifty pairs, and Berkeley, California, a club with over one hundred pairs, and judging from the pictures sent the writer from these clubs, the same phenomena hold good in these assemblages of unique human beings, since



INHERITANCE OF TWINNING IN BUSH FAMILY

TWINNING IN "W" FAMILY

TWO TWIN-BEARING FAMILIES

FIGURE 10. Males are denoted by squares, females by circles. Double symbols indicate twins. The last pair of twins in the Bush family are the two boys shown in the Frontispiece. All the pairs are monosexual twins in both families, but some of the pairs in the "W" family are known not to be identical. These charts do not tell much about the manner of inheritance of twinning, but they do indicate that the character is hereditary in some families, at least.

nearly all appear to be of the similar type. Another point we found was that as they approach each other in appearance almost, not quite uniformly, they express increasing fondness for each other. It could be imagined that if, through the inbreeding and assortative mating, husbands and wives should ever become as nearly alike in make-up as some of these twins are, that the divorce courts would be forced out of business. One twin, evidently highly educated, writes of herself and her brother, "reared under exactly same environment, but we have never agreed on anything. I love school work and he hates it. He dislikes everything I am fond of, although we get along well together." Two brothers, obviously unlike in appearance, write: "One is fond of outdoor life, and the other enjoys books and indoor study." Twins seem to have their drawbacks. One mother writes, "I am getting tired of having to drop my work and go to the other

end of the town to the school building to help the superintendent decide which twin he ought to spank and in some cases to decide which one he has already spanked."

Many superstitions evidently prevail about twins. Several persons wrote to ask if marrying a twin would not cause infertility, or else defective offspring. One woman, however, wrote that she had always heard that if she married a twin she could not produce children, when as she remarks, her "first baby was a set of triplets." This good woman got more than she bargained for.

I am able to present here by photographs which I have made, some interesting details of the Farmer twins, aged seventy-eight, who were among those at the "twin matinee." Each had an unusual configuration in the palm of his left hand, the remarkable likeness of which is scarcely revealed by the photographs. They grew up as hard working boys, handling stones and rough material, and from early life have been stone masons, having followed this craft for more than sixty years—two human generations—yet these rough environmental procedures, especially applied to the palms of the hands, have not prevented an almost parallel development of these physical characters. A small mole over the lid of the left eye in each twin has persisted since birth, indicating, perhaps, the marvelous minuteness of chromosomal control in ontogeny. When placed behind a screen several persons were not at all sure that they could distinguish their voices. Their children and workmen have always gotten them confused. At seventy-eight, their physical energy, as exhibited by a long walk which the writer took with them, and their movements are probably almost as nearly identical now as when they were born.

The Tomson twins were interesting since they related that their identity had been almost complete in the judgment of some of England's noted scientists. However, during the war they went through great separate experiences. They fought in different branches of the service. Both were wounded and one was gassed and they lay in separate hospitals for many months. They related that both in their own opinion and feelings, and in the judgment of their friends, these profound experiences had worked a change in their personalities and even physical appearance, so that they are not quite so much alike as before. This accords with the suggestions of Galton, F. A. Woods and others, that very great changes in the environment, especially extreme physical illness or trying experiences, will work a change in the moral and mental behavior.

However, they are still so similar that Sir Oliver Lodge has frequently entertained them for the observation of scientific men and they stated had recently "offered them $10,000 for their heads, to help him demonstrate telepathy."

Since they would often make the same side remark simultaneously in the midst of other conversation, or recall some similar memory, or express simultaneously the same desire and would give almost identical answers to questions when in separate rooms, Sir Oliver laid this to telepathy. In this connection, the Farmer twins related that on one occasion one was in New York and the other in New Orleans. Suddenly the New York twin became very much distraught and stated to friends that his brother was in great danger and needed him badly. This anxiety continued for precisely four days, and as suddenly disappeared. Information later developed that during these four days the New Orleans twin had been on a ship in a storm on the Gulf of Mexico, in hourly danger of going down. Page Sir Oliver!

The mother of the Fairbanks twins also stated that she had always tried

UNLIKE WHEN BABIES, AND HAVE REMAINED SO

FIGURE 11. A letter from one of these twins appears on pages 319-20. They have lived together all their lives, but this has not made them grow any more alike. In fact they report that they do not have even a family resemblance now.

to have the young ladies write their school compositions in separate rooms and without mutual discussion. Nevertheless, the teachers constantly accused them of copying each other's material. On one occasion they were to write four themes on given subjects and then each was to choose a fifth theme for herself. Both the twins and their mother related that they tried to keep their fifth subject secret from the other twin and their mother put them in separate rooms to write. They were themselves considerably astonished to find on comparing their work that one had written on "A Summer Shower" and the other on "An April Shower." The mother very sensibly laid this to similarity of environment, habit and physical organization, which to the writer's mind explains Sir Oliver's telepathy insofar as it may be proved by twins.

The two following letters are of great interest since they bear upon the hereditary-environment problem. One pair of dissimilar twins was reared together and the other pair, similar twins, was reared apart. I leave these persons, evidently of good sense and education, to tell their own experiences.

Mrs. Frank Prenschoff, of Petersburg, Alaska, describing herself and her identical twin, who lives in Saskatchewan, Canada, writes:

We are girl twins, age twenty-five years, both married. I live in Alaska, while my sister lives in Saskatchewan, Canada. Unlike most twins who are always together, and who dress and talk the same, fate

SO MUCH ALIKE THEIR MOTHER CONFUSES THEM

FIGURE 12. Twins have their disadvantages. One mother writes that she is getting tired of rushing to the other end of the town to help the school superintendent decide which twin he should spank, and in some cases which one he has already spanked. The mother of these two young ladies would be able to offer small assistance, as she has difficulty in telling her own daughters apart.

seems to have kept us apart nearly all our lives. We were not raised together and have not seen very much of each other, but for all that we have always been very fond of one another and are as alike as two peas in a pod. We look alike, act alike, talk alike, and talk is the main thing we do when together. We seem to catch each other's ideas perfectly and often both start to say the same thing at the same time.

My sister married quite young, several years before I did. We were raised under entirely different environments. Our mother and father separated when we were four years of age, and my sister was raised by a friend of my mother's people, who has no children of her own. Consequently, she was raised as an only child, while I was one of a large family of children, my mother having married again.

We had only seen each other once before my twin sister came to live with us for a year, at the age of fifteen, and we were surprised to see how much alike we were, our tastes being all but the same, in dress and manners, so that even our mother would often mistake us.

Let us contrast this letter from the Prenschoff sisters who were born alike and remained alike in spite of all changes of environment, with the following from Mrs. X and her twin, who were born *unlike* and remained *unlike*, despite all the efforts of similar environment to mold them into a common pattern.

As for our appearance, as a child I was fat, blonde and healthy. My sister was thin, blonde and much weaker. She is still thin and has to watch her health. Since

adolescence, she has become a brunette, with high color when well. She is five feet and one inch in height and weighs about one hundred. I am plump and robust, medium complexion, five feet three inches tall and weigh 130. We both have brown eyes, hers very dark, mine inclined to hazel. Her hair is massive, heavy and a bit coarse, while mine is shorter, lighter and extremely fine. We both have small hands and feet, mine unusually so, enough to rouse comment wherever I go.

We have never agreed on any subject, yet never quarreled. We used to use our fists and tear each other's hair when children. We were always inseparable chums until our school days were over. She has no aversions that I know of, while I lose all control of myself if a bee buzzes around, due to a fright in childhood, I think. We have always done well in school. I was always the pest and my sister the pet of our classes. She studied hard and I didn't, but all our marks were good and alike except for deportment. My sister's marks were especially fine in history, geography, etc., while I shone in botany, physiology, algebra, music and English. She used to have nightmare over geometry until her doctor had her drop it. Nothing ever worried me.

We lived together until 1917. We were born in Pasadena in 1894, being now twenty-seven years of age. Our father was a captain in the army. Our mother died when we were four and we were brought up by five great-aunts. At the age of ten we were taken to Massachusetts to be educated, and then came further changes for us both. An aversion was taken to me by our aunts on account of my father, whom I exactly resembled in appearance and disposition. A violent, unreasoning temper was aroused in me by this attitude, and my life while there was a stormy one. I have learned to control my temper since then, I am glad to say. My sister's deportment at home was as excellent as in school, but a tendency to selfishness and obstinacy became manifest.

After leaving high school on account of my twin's health, it was decided that we go to the Sargent School for Physical Education. It was a wonderful school and we both loved it. Her health became fine and mine remained so. While there I found that while I had the endurance for long hikes, fencing and rowing, she won out when it came to tennis, swimming, jumping and muscular strength for shot putting and the like. She could go over a wall like lightning, while her plumper twin took minutes.

We haven't even a family resemblance. My sister resembles my mother's side wholly and I my father's side wholly. No one will believe that we are twins. We grow more unlike as we grow older and marriage will, of course, bring greater changes.

Personally, I do not think that such "instances," unsupported by exact measurements, settle for us the heredity-environment problem, although they do illuminate it. In this connection, I feel that all biologists and psychologists owe a debt to Prof. Edward L. Thorndike, of Columbia, for having stated this infinite complex with a clarity and definition that probably has been nowhere equalled. If this statement were kept hung up in the laboratories of all students of the problem it would probably act as a demurrer to stating that any particular trait or character or performance is due, so many per cent to heredity and so many per cent to environment. Although the large rough outlines of the two forces can, I think, be delimited by modern methods of study. On page 2 of his "Original Nature of Man," Prof. Thorndike writes (the italics are mine):

> But in another sense the most fundamental question for human education asks precisely that we assign separate shares in the causation of human behavior to man's original nature on the one hand and his environment or nurture on the other.
>
> *In this issue* we negelect to take for granted the co-operating action of one of the two divisions in order *to think more successfully and conveniently* of the action of the other. Thus, we say that man is by his original nature *able* to see, but *what he sees* depends upon the environment he meets; or that original nature makes him respond to certain objects by fears which environmental training weakens; or that a child *instinctively* conveys food to his mouth with the naked hand but by habit comes to use a spoon as well; or that *native curiosity* develops by proper training into interests in the arts and sciences.
>
> The custom of abstracting out the original nature of man in independence of any and all influences upon it is *so general and so useful* it is best to follow it throughout, *remembering, however,* that from the first moments after the fertilization of the ovum a human individual is always an *acquired nature*—that in the most original behavior discoverable, such as breathing or suckling, some outside conditions are involved and that in the most exclusively acquired

ACTRESS TWINS

FIGURE 13. The DeMar sisters' voices are indistinguishable except in singing. For professional reasons one has learned to sing contralto while the other retains her natural soprano voice. Height, weight, habits, tastes, hair and eye-color, likes and dislikes are remarkably alike.

or learned arts, such as knowledge of the square root of 256, some element of original capacity has a share.

We have recently witnessed numerous popular, largely rhetorical, tirades against mental testing on the ground that it did not measure "heredity alone" or "intelligence alone." No psychologist of whom the writer is aware has ever claimed that he had measured heredity or intelligence "alone." One writer exclaims with rhetorical flourish that he "has won his case" if he has proved that intelligence tests have not measured hereditary intelligence separate from all environmental influences. His "case" never existed. It is admitted in advance. But biologists and psychologists have found that the assumption that they were measuring either native endowment or else environmental influences separately has enabled them "to think *more conveniently and successfully*" and the method is "*so general and useful*" that they have made great advances towards solutions of some phases of the problem and illumination of others. Despite the warnings of popular journalists who have never been inside of a laboratory, they have thought it "*best to follow it throughout,*" and will probably continue to do so, "*remembering always,*" as all sound students of the problem do, the qualifications which Prof. Thorndike cites, which are inherent in the very nature of protoplasmic movement and which in human beings rise to the point of seemingly purposive behavior.

Consequently the above data is merely cited as being in harmony and not in discord with the general trend of more exact investigations.

Many twins have written of other sets of twins among their relatives, some of which data is being perused by Dr. Charles B. Davenport, to whom the correspondence has been handed. Two pedigrees are presented herewith, made up from the statements of informants and are probably exact. They throw little light upon the method of inheritance but emphasize the notion that twinning is probably a hereditary trait in some strains of the human family.

Social Conflict and Education

(*Continued from Page 296*)

lucid and disinterested presentation procures a hearing for his program of adustment by progressive leadership.

The greatest force in effecting this ideal social organization for the common weal is, Professor Williams believes, education. Throughout the book are statements of the need and power of education to right a wrong condition. The press, labor unions, religion, are recognized as educational media supplementing schooling.

Real education is a powerful factor in progress. Education is recommended to improve such seemingly divergent conditions as those of industry and academic life. There is no greater study than man and the author's plea for a study of psychology in its social relations is well founded. The hereditarian, however, believes man in his biologic relations a greater study. Nevertheless the chapters on public education are particularly valuable; they should be of especial interest to educators and students of environment.

However difficult of achievement any ideal organization may be, we are bound to adopt Professor Wiliams' attitude that knowledge is power. Intellectual analysis is a force of progress. Let us then have presentations by such able analysts as the author. Through his writings a teacher of the world beyond the classroom, "he addresses directly the thoughtful man in whatever class he may be found. And the aim is not for his assent but to challenge thought and perhaps dissent."

F. L.

MALFORMATIONS OF COTTON PLANTS IN HAITI

A New Disease Named Smalling or Stenosis, Causing Abnormal Growth and Sterility

O. F. Cook

U. S. Department of Agriculture

A PECULIAR disorder of cotton plants was found in China in 1919, as described in the JOURNAL OF HEREDITY for March, 1920, under the name club-leaf, or cyrtosis. After growing normally as seedlings and into the stages of flowering and fruiting, there is an abrupt change to an abnormal habit of growth with the branching irregular, the leaves contracted and distorted, and the floral buds mostly aborting. The danger of introducing such a disease into the United States was recognized.

A similar affection of cotton, with even greater extremes of reduction of the leaves and other organs, was seen recently in the north-central part of Haiti. Several fields were visited July 27, 1923, in the vicinity of St. Michel, within a radius of about three miles. Definite indications of the disease were found in all of the fields, but with wide differences in the numbers of plants affected as well as in the nature and extent of injury of the diseased individuals.

Though most of the cotton was of the Meade variety, Lone Star, Durango, Acala and other varieties of American upland cotton were represented, as well as Sea Island cotton and the type that is considered as native Haitian cotton. In some of the fields there were many hybrids between the Meade Upland cotton and the Sea Island and also crosses of these types with the Haitian cotton. A special interest attaches to the Haitian cotton on account of its apparent immunity to the disease. The development of uniform productive strains of this cotton or of some other immune type is the obvious way of controlling the disease.

Other plantings of Meade cotton at Bon Repos, a few miles from Port-au-Prince, showed no such deformities. This district is in the plain of Cul-de-Sac, nearly at sea level, while the St. Michel district has an altitude of about 1,200 feet and represents the interior plain or plateau region of Haiti. Unlike most parts of Haiti, this interior plateau region is but little inhabited. It is a gently rolling grass-covered country, not unlike the South Texas prairies. A large cotton-growing enterprise was established at St. Michel by American capital during the war period. The presence of this disease is a factor that could not be reckoned, as there is no similar disease in the American cotton belt. Also the dominant grasses of the Haitian savannas, identified by Mrs. Agnes Chase as *Themeda arguens* and *Sporobolus indicus*, are much more refractory than the Texas prairie grasses.

Comparison with the Chinese Disease

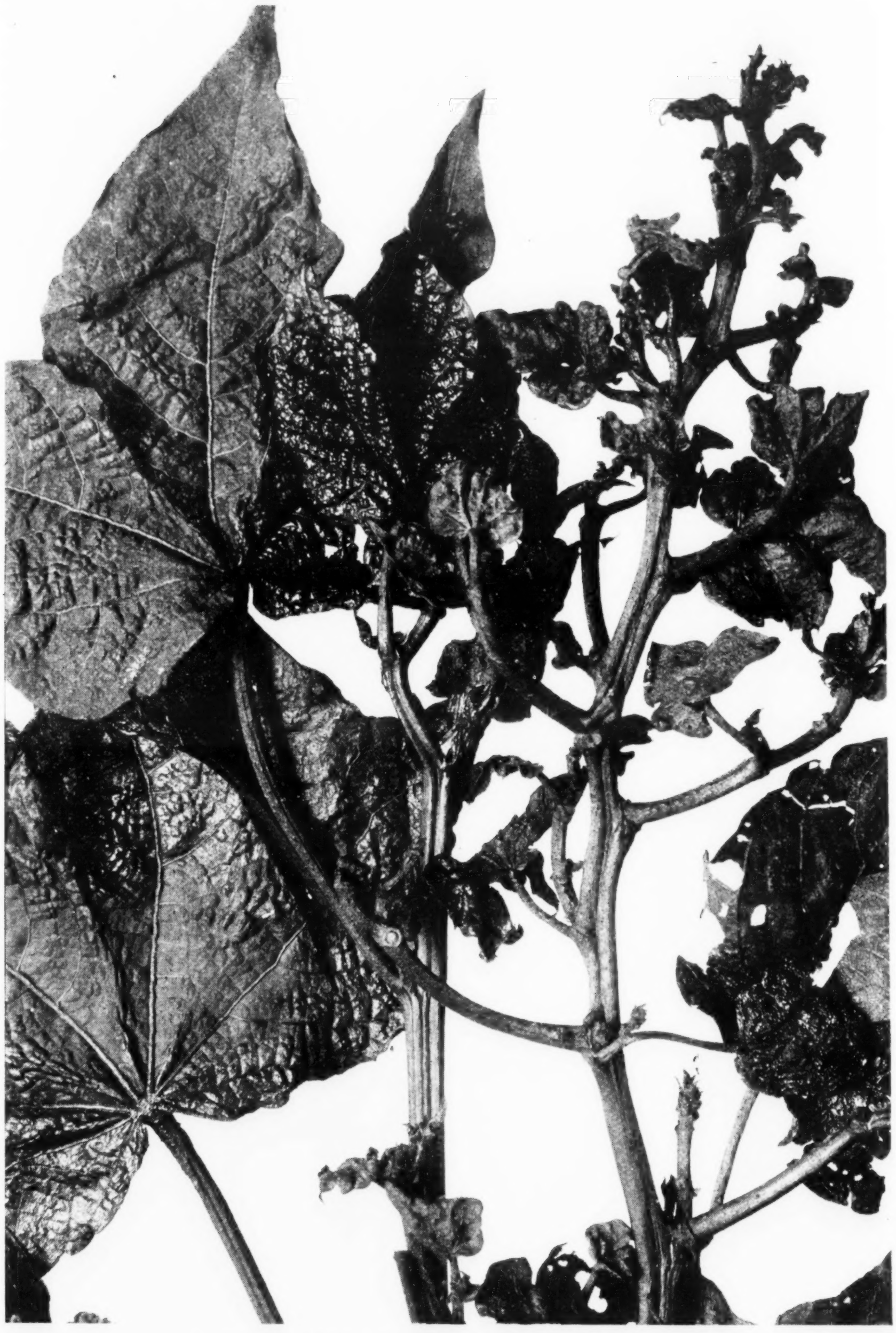
The two disorders show very similar results in altering the behavior of the plants, and undoubtedly belong to the general group of so-called "mosaic" diseases, which in some cases are caused by leaf-hoppers. The affected plants usually are more or less deficient in chlorophyll and show different shades of color with angular spots or areas, some of lighter and some of darker green, fitted together like a mosaic. In Haiti this feature is less

A NEW DISEASE OF COTTON IN HAITI

FIGURE 14. The name smalling, or stenosis, is proposed on account of the dwarfing effect. The disease affects the growing tissues of the plants and results in great distortion and reduction of the stalks, branches, leaves and floral organs. It is like the club-leaf disease of cotton in China, but with the distortion and dwarfing symptoms more pronounced, especially in the Upland type of cotton. Since the diseased parts are sterile, the production of a crop is restricted to the normal early growth of the plants, which shows no injury from the disease. This photograph shows the ends of two diseased plants of Meade cotton, the left-hand plant with only slight injury, the right-hand plant with the internodes and petioles shortened, the leaves much reduced, and short, abortive, supernumerary branches. (Natural size.)

SEVERE CASES OF SMALLING DISEASE OF COTTON

FIGURE 15. Two diseased plants of Meade cotton at St. Michel, Haiti, showing extreme conditions of abnormal growth, with leaves and floral buds abruptly reduced to very small size. Note that the abnormal growth is definitely different in the two plants, and that both plants had produced normal stalks and leaves in the earlier stages. All of the later growth is extremely contracted, with very short internodes and excessive numbers of diminutive leaves and floral buds. Abnormal branching is a feature of this disease, notably in the right-hand plant, with many small shoots and minute rudiments of leaves, similar to "witches' brooms." (Natural size.)



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prominent than in China, the marginal areas being chiefly affected and those that are intermediate between the principal veins. The marginal and intermediate areas show a paler green at first, then become red, and finally turn brownish and die.

Some of the mosaic diseases have been traced to bites of insects, which are supposed to convey organic infections or protoplasmic poisons that are able to extend like enzymes through the whole system of the plant, though the injuries become apparent only in the new growth of the plants, which is discolored and distorted. The change from the normal to the abnormal growth appears very abrupt. The leaf that subtends a fruiting branch may be quite normal, while the first leaf of the fruiting branch is definitely affected. The effects of the injury are the same in the different parts of the plant, the same abnormal characters appearing at the top of the plant and at the ends of all of the growing branches.

Whether unknown parasitic organisms are involved in such diseases, or injurious chemical compounds acting like ferments or enzymes, the effects upon the development of the plants are of much interest from the standpoint of heredity. The aberrant growth of the plants shows very clearly that the normal course of development, as determined by heredity and manifested in the normal early growth of the plants, is subject to serious and persistent derangements through some cause or causes that are still unknown. The investigation of such abnormalities may throw light on problems of heredity, in addition to the purpose of avoiding losses of crops.

The Upland type of cotton in Haiti showed a more general distortion and buckling of the leaves, with less tendency to discoloration and rolling-under of the leaf-margins, which were the special symptoms with Upland cotton in China. On badly affected plants in Haiti where the leaves were dying, they turned red along the margins and between the veins, though these symptoms did not appear with such regularity as in China. In severe cases, the reddening goes in between the veins, the tissue dies, and the margins become ragged, or the leaves may become quite deeply dissected as the tissue dies back between the veins.

The behavior of Upland cotton in Haiti is more like that of the Asiatic type of cotton in China, except that the growth of distorted leaves did not form such dense, club-shaped masses as in the Chinese cotton. The dense masses of foliage in the Chinese cotton resulted from shortening the internodes and increasing the number of branches, which also are features of the Haitian disease, but not to the same extent. On the other hand, the tendency to reduce the affected parts to very small size is carried notably farther in Haiti than in China. There were not in China such extreme cases of reduction of leaves and flower buds as shown in Figure 16.

The symptoms of the disease in Haiti did not seem to be modified by the conditions in the same way or to the same extent as in China. Though some plantings seemed to be more seriously and more regularly deformed, like the field planted to Lone Star, cases of extreme deformity and dwarfing also occurred among the normal, uninjured plants. This is consistent with the other fact of a wider range of diversity in the nature and extent of distortion and dwarfing of growth in Haiti. As with the Chinese disease, the Sea Island type of cotton showed less dwarfing and distortion than the Upland type. One variety of Indian cotton with very hairy leaves seemed to be immune to the Chinese disease, while the so-called "native" cotton in Haiti seems not to be affected by the smalling disease.

Analogy of Gall Formation

That there are substances which have a specific action in changing the course of normal development and producing abnormal growth, is shown by the familiar phenomena of gall-formation. Since the same plant may pro-

duce different kinds of galls, in response to the injuries of different insects, there can be little doubt of the specific effects of the insect secretions in producing malformations of the growing parts of plants.

The distortions produced by the mosaic diseases may be thought of as relatively slight and generalized gall-formations, or as analogous to the so-called "witches' brooms." These analogies would apply whether the poisonous substances are supposed to come directly from the insects, or to come from bacteria or other parasitic organisms conveyed by the insects and able to live in the cells and alter the habits of growth, as in the case of the crown-gall bacteria investigated by Dr. Erwin F. Smith. But instead of the definite reactions seen in the formation of galls, or in the abnormal branching that results in "witches' brooms," these mosaic diseases have more generalized effects through unbalancing of heredity. It is conceivable that the secretions of a parasite, or other poisonous substance, might disturb the normal relations of development in the same way that the placing of plants in a new environment sometimes calls forth a large amount of variation. Results recently reported by Mavor and Svenson of experiments with fruit flies, show that exposure to X-rays increased the number of cross-overs, or hybrid combinations of character by reducing the normal tendency of characters derived from the same parent to cohere or remain associated in the hybrid progeny.*

Varied Proportions of Diseased Plants

Assuming that the Haitian disease is of the same general nature as that of China, the varied proportions of affected plants in the different fields in Haiti is a feature of interest as throwing light on the nature of the disease. Such evidence was not obtainable in China, because all of the plants were affected. The difference may be explained by the great abundance of leaf-hoppers in the Chinese fields, whereas leaf-hoppers were not noticed in Haiti. Specimens of the Chinese leaf-hoppers have been identified by Mr. W. L. McAtee as species of Empoasca and Eupteryx.

Many different forms and degrees of distortion were observed among the individual plants in China, as in Haiti, but in the central districts of China that were visited the club-leaf disease appeared universal. At least it was so generally established in the fields by the end of the season, that all of the late growth was more or less abnormal. Contrasts were afforded between the normal early growth and the distorted late growth, but there were no normal plants to compare with those that had suffered injury and distortion, so that in China the idea of an external environmental cause of the injuries could not be so definitely excluded.

Only one of the fields in Haiti, planted to the Lone Star variety, had all of the plants affected. The distortion of the later growth in most cases was great, and no individual was found that was producing new normal growth. The early growth had been normal for a sufficient period to allow many normal bolls to develop, though not attaining the full size of the variety as it grows in Texas. One large plant was noted that apparently had escaped injury much longer than the others and had produced larger and more numerous bolls, but even in this plant the new growth was distinctly distorted.

Most of the fields at St. Michel were of the Meade cotton, in some places with the disease nearly as bad as in the Lone Star field, in other places with normal and abnormal plants mixed in varied proportions. Some of the fields were affected to only a slight extent, with the distorted plants appearing as scattered individuals, estimated at five per cent or less of the plant population. Only a few rods away the proportion of injured plants might be much higher, showing that the agents of infesta-

*Science, August 17, 1923, page 124.

tion had been more numerous or more active in some parts of the fields than in others.

It seemed very remarkable to see badly crippled and dwarfed individuals with plants on either side two or three times as tall, of normal stature and leaf formation, even to the top growth. It was plain that injury or infection of the crippled individuals must have occurred at a rather definite stage of development, and that the insects or other agents of infection had been few in number and had worked in the fields for only a short time, or some of the plants would show later injury. The injured individuals showed that the disease had been present for many weeks, and the absence of late infestations could only be taken to mean that the agents for communicating the disease could not have continued their work in such fields, unless it be assumed that the plants are susceptible at a certain age or under some special, temporary condition.

Varied Forms of Distortion

The Haitian disease, like that of China, is not manifested by a definite form of injury to the plants, but results in various kinds and degrees of malformation, showing that the normal heredity or course of development of the plants is profoundly disturbed. Try to imagine a human disease that could turn all the children of a city or a section of country into cripples, with the different parts of the body distorted in various ways, or sometimes lacking altogether. In such a population the preservation of normal heredity would be an acute problem. Not only are questions of resistance or immunity involved in the study of such a disease, but the marked deviations from normal heredity are of interest as showing how the "mechanism of heredity" may be deranged.

The nature and extent of the deformities may be judged from the photographs and explanations that are given in the legends. Figure 14 shows a plant that was only slightly distorted and another that represents a rather frequent type of more severe injury, neither of these plants producing floral buds. More severe crippling is shown in the two plants of Figure 15, one with the leaves and flower-buds reduced to very small size, and the other an extreme case of dwarfing, with the internodes extremely short. This plant had grown only about four inches after it became affected, the leaves and flower-buds being reduced nearly to microscopic size. Earlier in the season both of these plants had produced leaves of normal size and shape, showing that they were not natural or congenital dwarfs, but changed suddenly into the crippled state after a period of normal development.

Perhaps the most characteristic feature of the disease, as showing that it is different from the Chinese disorder, is the development by many of the affected plants of large numbers of small flower-buds. Some of these may be restricted to very small size as on the plants shown in Figure 15, but not infrequently the development continues to the flowering stage, some of the plants producing large numbers of under-sized flowers from the dwarf buds, as in Figure 16. In such cases abortion usually takes place soon after flowering, but small distorted bolls are retained by some plants.

As in the Chinese disorder, some of the badly crippled plants have the leaves crumpled or buckled and with irregularly torn or eroded margins, and some plants have leaves with irregular perforations or scars of partially united tissue, very similar to the tomosis or leaf-cut disease of young cotton in the United States, but apparently continuing for the life of the plant in these abnormal individuals. Such a plant is shown in Figure 16, with several of the leaves taken separately after boiling, to restore the natural turgidity and configuration.

The reason for considering these widely different abnormalities as symptoms of the same disease is that the diversity is so general and that there

seems to be no break in the series that would require the assumption that two or more diseases are involved. Many of the abnormal plants probably could not be distinguished from extreme cases of degenerate "rogues" or perjugate hybrids, and these factors of diversity were present also in the mixed fields. But the disease injuries were equally severe in the more uniform unmixed stocks, grown from newly imported seed.

It may not appear reasonable to suppose that so much diversity arises directly from one cause, unless it is considered that the diversity is in the plants rather than in the disease, so that the disease is considered as a disturbing factor rather than as a definitely directive agency, such as the insect secretions that produce galls. This distinction makes it possible to think of the disease as disturbing the growth of the new tissues, without affecting the tissues already formed. In some of the mosaic diseases where seed has been grown from affected plants the seedlings proved to be normal, which would indicate that the germ plasm is not affected, but only the growth processes.

The Disease Not Contagious but Infectious

It was plain that the disease was not contagious in the ordinary sense, but required some active agent of transmission that had been present temporarily, and had later disappeared. Later infections must have occurred, if insect conveyors of the disease had continued to work in the fields after some of the plants became affected. Such evidences of spread of infection were looked for in places where the injured plants were few, but the uninjured plants remained normal to the top, while adjacent individuals had been crippled from an early stage of growth, when the stalk was only six to eight inches high.

That only a few plants were injured in some places may be due to small numbers of insects that were present, or to the sources of infection being scarce or remote. The occurrence of such a disease, and the extent of injury might vary greatly with the seasons, depending upon the abundance of insects or upon the existence of the disease in a native host-plant of the insects. Hence it would seem desirable to study the native cotton and related plants as having possible relations to the occurrence of the disease. Since the period of insect activity may be short, the season of planting might largely determine the amount of injury. Earlier planting might secure more growth in advance of the disease, while plantings made late enough might escape entirely.

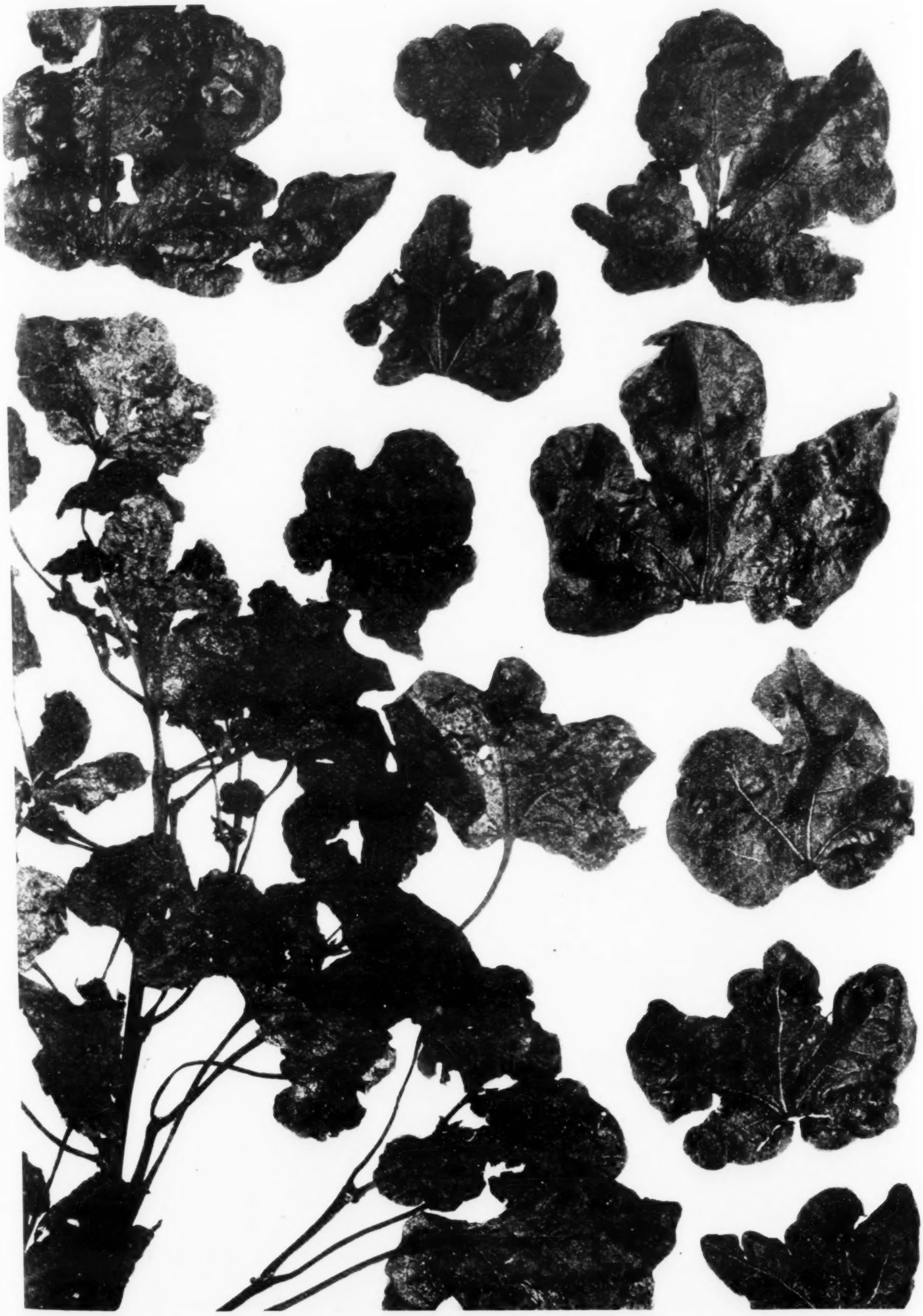
The only disease or disorder of cotton thus far recognized in the United States as possibly analogous to the Chinese and Haitian diseases is one that has attracted attention for the last two or three seasons in the Salt River Valley of Arizona. The popular name "crazy-top" is being applied by the farmers, on account of the abnormal branching and sterility of the upper part of the plant. The abrupt change from the normal growth and branching of the lower part of the plant is a feature of similarity with the mosaic diseases.

Sterility and abnormal branching habits are the more notable features of the disease in the Pima or Egyptian type of cotton, but in the Upland varieties that are now being planted in the Salt River Valley there are more pronounced symptoms of reduction, crumpling and crowding of the leaves, which may represent the same disorder. The branching of such plants is distinctly abnormal, with many axillary shoots, decurrent stipules, or fasciations. The floral buds and bracts also have a very restricted development, so that few bolls are produced, and these usually are very small.

The occurrence of the "crazy-top" injury is also very erratic, with no apparent relation to cultural conditions. The injured plants may be sprinkled indiscriminately among normal individuals, or in some places a majority

SMALLING DISEASE WITH REDUCED INVOLUCRES AND FLOWERS

FIGURE 16. The distortion is less extreme than in Figure 15 and the buds develop to the stage of flowering, but the leaves, bracts and flowers are notably reduced, with the involucres restricted to small size and the petals often very short, as in the lower flower. The leaves are narrowed and deeply lobed, with the surfaces and margins uneven. Note the contrast in leaf-forms with Figure 17, and also with Figures 14 and 15, as showing the wide range of diversity in the abnormal growth induced by the smalling disease. (Natural size.)



SMALLING COTTON DISEASE WITH CRUMPLED LEAVES

FIGURE 17. Sterile growth of a Meade cotton plant, with short-lobed, crumped leaves. Many of the leaves had deeply eroded margins and irregular perforations, partly healed or regenerated, as in the leafcut or tomosis disorder which is common in the United States. Usually tomosis is confined to the seedling stage of normal plants, but sometimes continues throughout the life of degenerate hybrids or "rogues." Such mutilations of the leaves are caused by the death of small areas of the leaf tissue at very early stages. The oil-glands die first, in advance of the neighboring cells. (Natural size.)

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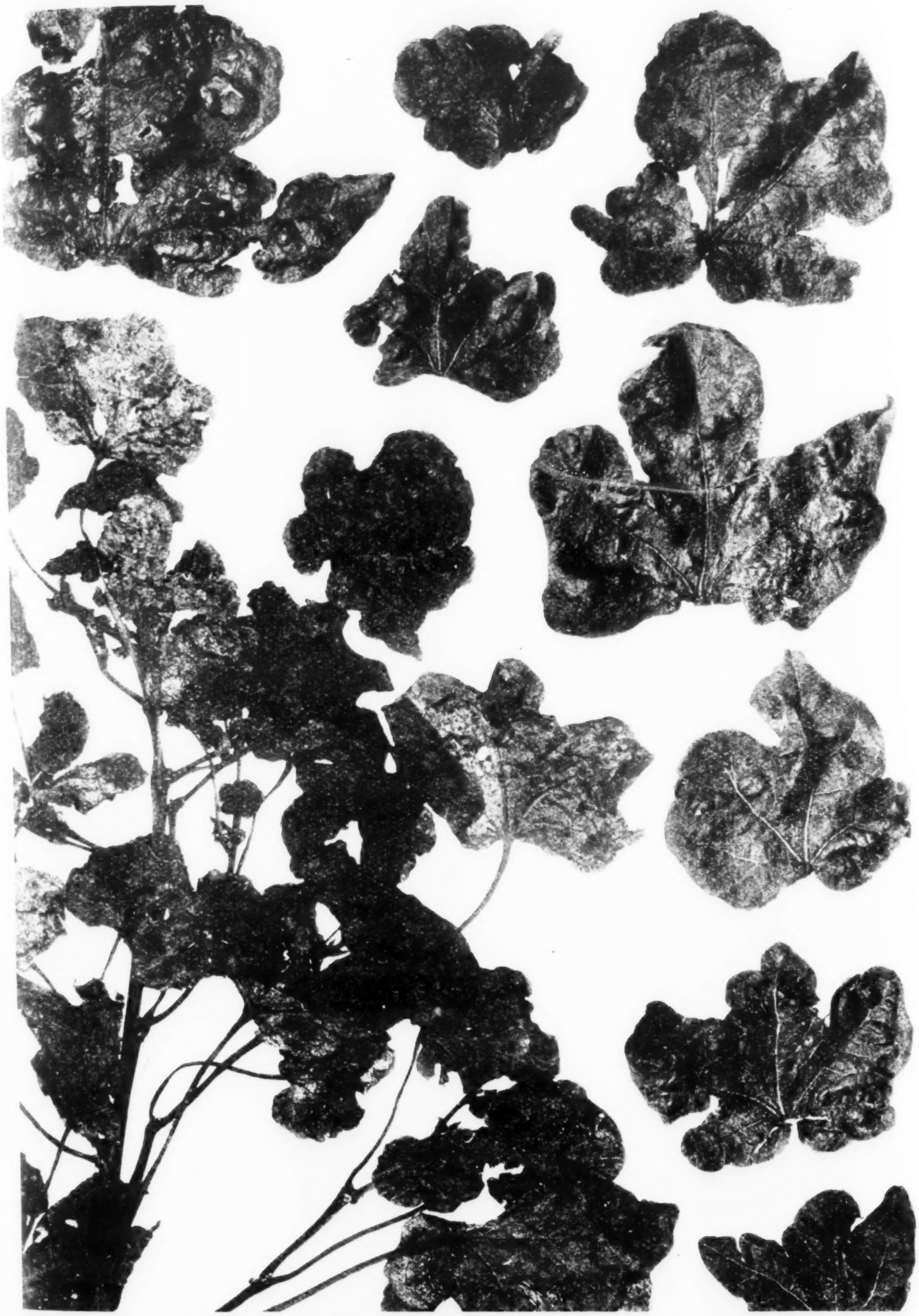

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PLANTS OF THE BOURBON COTTON IN HAITI

FIGURE 18. The "Native Haitian" or Bourbon cotton (*Gossypium purpurascens*), which showed no symptoms of the smalling disease. This species is very common in Haiti, both cultivated and half wild, in waste places, and furnishes most of the cotton that is exported. It is a perennial shrub, often attaining ten to twelve feet in height. The general appearance of the foliage is not unlike American Upland cotton but the Upland varieties from the United States usually grow three or four feet tall in Haiti. The fiber is like Upland cotton, with staple from an inch to an inch and a quarter. *Photographed by C. B. Doyle, at Gonaives, Haiti, September 5, 1913.*

DETAILS OF THE HAITIAN COTTON

FIGURE 19. A fruiting-branch of the native Haitian or Bourbon cotton, with floral buds or "squares," a flower, a young boll, and a mature boll, in natural size. The boll is more rounded at the tip than usual, most of the bolls having a distinct short point. The petals are yellow with a purple spot at the base, as in Sea Island cotton, but the leaves and the bracts of the involucre are most like Upland cotton. The bracts commonly are united at the base as in Egyptian cotton. Since this type of cotton apparently is immune to the smalling disease, it may be better suited to cultivation in Haiti than the American Upland type, so that the breeding of uniform and productive varieties of Bourbon cotton would be a means of avoiding injury from the smalling disease.

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2, 1917.

of the plants show the "crazy-top" injury, with occasional individuals that remain normal. Thus the mode of occurrence may indicate an insect-borne disease of the mosaic class, but with the external symptoms much less striking than in the Chinese and Haitian diseases.

No Indication of Recovery

With this indication that the cause of the injury had disappeared from such areas, greater significance may be ascribed to the fact that the injured individuals continued to grow abnormally instead of recovering as would be expected if the disease were of the temporary nature of plant-louse injury which ceases to affect the plants as soon as the cause is removed. In India and also in Nyasaland, according to Mr. H. C. Sampson, there is a temporary disorder of cotton leaves due to attacks of Jassidae, which may seriously cripple the plants during the rainy season, but after the insects disappear, in the dry season, the plants recover and resume their normal habits of growth. With the Chinese cotton disease all of the plants were affected, and no indications of recovery were noted. In some cases the later growth appeared less distorted, but this was considered as a result of more moderate conditions in the latter part of the season, the amount of distortion being determined to a considerable extent upon the conditions, though the presence of the disease is still apparent in plants that grow with the least distortion.

In this respect the Haitian and the Chinese diseases may be contrasted. Not only is there a wider range of degrees and forms of distortion in the Haitian disease, but there seems also to be less relation to the external conditions. Some of the extreme cases of crippling like that shown in Figure 16 were found in places where the uninjured plants showed that conditions had been very favorable for normal growth.

Immunity of the Haitian Cotton

The so-called native cotton may be of interest in two ways in relation to the disease. The fact that the disease apparently does not injure this type of cotton does not prove that the infection might not come from the immune cotton. The insects that cause the disease might feed on the native cotton, or even make it their regular home. This would be the more possible because the native cotton is a large perennial bushy plant, often growing to a height of eight or ten feet, with woody stalks often two inches or more in diameter at the base. It is generally distributed about the towns as well as in the rural districts of Haiti, either as a dooryard plant or growing half wild in neglected grounds or waste places.

Of course, it is possible that a closer study might detect a slight injury of the native cotton, but most of the plants appeared to be quite uninjured. A few cases of plant-louse distortion were observed in the Haitian cotton. Red spiders and black-arm were prevalent and appeared also on the Haitian cotton, with occasional plants showing distinct susceptibility. One plant afforded a rather striking example of the "rust" caused by red spider, with the leaves discolored and distorted over half the surface while on adjacent plants the red-spider injury was confined to small yellowish spots between the bases of the principal veins.

A notable diversity in form, color and hairiness of the leaves may be ascribed to crossing with Sea Island or Upland types. Several forms of Sea Island cotton have been observed in Haiti, and are widely scattered, but in no such abundance as the Bourbon cotton.

A planting of the Lewis variety of Upland cotton from North Carolina was seen on La Gonave Island September 17, 1917, and in the same garden a tall, upright, purple "native" cotton. The foliage of the Lewis cotton was very pale green, with the leaves and stems distorted, and the branches very

short-jointed. The leaf surfaces were uneven and buckled, with the color varied from a finely mottled pale yellowish green to much deeper green in bands along the veins. Many of the involucres were abortive, consisting of a single bract. The possibility of a physiological, chlorosis disease, due to excess of lime, was suggested by the very pale color, but the purple "native" cotton had normal dark foliage. Another form of mosaic disease may be indicated, with less reduction and distortion, but the color reactions much more pronounced.

Haitian Cotton Not Related to Sea Island Cotton

Visitors from the United States often suppose that the Haitian cotton belongs to the Sea Island type because the plants grow tall and the flowers are golden yellow, with purple spots at the base of the petals. Also the seeds are smaller and generally less fuzzy than in American Upland cotton. But those who are familiar with Sea Island cotton will see at once that the leaves of the Haitian cotton are entirely different, being relatively broad and short, and usually with three lobes instead of the five lobes of well developed leaves of Sea Island cotton. Also the lobes are short and rather divergent, not separated by deep cuts nor with the lobes partially folded, to render the upper side of the leaves deeply channeled. Thus with respect to the leaves the Haitian cotton appears much more similar to the Upland type, especially the plants that are somewhat hairy. Also the bolls are of a light green color, more like those of Upland cotton.

In reality the resemblance of the Haitian cotton to our American types is entirely superficial. No such cotton has been found in other parts of America that have been explored, in the continental regions. The Haitian cotton is not really a native species, but probably was brought from the East Indies during the period of the French occupation. It undoubtedly belongs to the species that is known botanically as *Gossypium purpurascens*, and usually is called Bourbon cotton, from the Island of Bourbon, now generally known as Reunion, east of Madagascar in the Indian Ocean, whence it is supposed to have been carried by French colonists to different parts of the world.

The salient characteristics of this type of cotton are the tall growth and perennial habit, the purple color of the stalks, branches and petioles, with prominent black oil-glands, the broad, short leaves mostly with three short, divergent lobes, the short calyx, the large yellow, purple-spotted flowers, the rather small oblong-elliptic bolls, more or less apiculate, and the small, slightly fuzzy seeds.

Though apparently not cultivated in any of the more important producing countries, the Bourbon cotton has been widely distributed in the tropical regions, especially in the Old World. It is grown to a slight extent in India and, according to Mr. Sampson, is there considered immune to the attacks of the insects that in other types of cotton cause a serious distortion of the leaves, as already stated. But the insect injuries in India apparently are not the same as those in Haiti, since the cotton in India is said to recover completely in the dry season after the Jassidae disappear, whereas in Haiti the disease apparently continues in unabated form long after the agents of infection have ceased their work.

Where recovery is possible, as in the distortion caused by plant lice, the theory of permanent infection by a parasitic organism would seem less applicable, so that two classes of diseases might be distinguished, as recoverable or as permanently infected. Abnormal behavior or diseased conditions of cotton have been described from the Virgin Islands and elsewhere in the West Indies, but without definite indications of the smalling disease.

HEREDITY AND EUGENICS

A Review

GRUNDRISS DER MENSCHLICHEN ERBLICHKEITSLEHRE UND RASSEN HYGIENE. Vol. I, MENSCHLICHE ERBLICHKEITSLEHRE, by DR. ERWIN BAUER, DR. EUGEN FISCHER and DR. FRITZ LENZ, pp. 442; Vol. II, MENSCHLICHE AUSLESE UND RASSENHYGIENE, by DR. FRITZ LENZ, pp. 364, 2nd ed. Price of Vol. 1 in paper, $2.25; cloth, $2.50; Vol. II, in paper, $1.75; cloth, $2.00. J. F. Lehmann's Verlag, Munich, 1923.

Little more than a year has elapsed since the first edition of this encyclopedic work appeared, and now a second edition is at hand, enlarged and improved. Professor Baur (who deals with genetics) and Professor Fischer (who treats of anthropology) have made little change in their contributions, but Professor Lenz, who is responsible for the greater part of the work, has added a hundred pages of new material to each volume. The work is, of course, open to many minor criticisms, but on the whole it is worthy of the best traditions of German scholarship, and is to be warmly recommended to all who seek a comprehensive picture of the science of eugenics as it is understood in Germany (where, by the way, it has received much attention since the war). Practical measures by which eugenics might be furthered are discussed by Dr. Lenz specifically under sixteen heads, an enumeration of which will give a fair idea of the trend of his thought:

1. Combatting "racial poisons," such as alcohol.
2. Combatting venereal diseases.
3. Methods for cutting off defective lines of descent (segregation of the feebleminded and others).
3. Prevention of the marriage of the unfit.
5. Measures (such as a form of insurance) that may help superior parents to have more children.
6. Pay and occupation in their relation to eugenics.
7. Taxation.
8. Inheritance laws.
9. Rural colonization ("back to the farm"), a measure to which the author attaches much importance.
10. Direction of German emigration, which should be toward Russia and Siberia, the author thinks.
11. Social reforms involving a happy medium between state socialism and a capitalistic regime.
12. Changes in the educational system.
13. Research and propaganda in eugenics.
14. Health and eugenic surveys of the population.
15. Direction of the medical profession toward preventive medicine.
16. Protection of the Nordic race.

A final section of sixty pages on "personal eugenics" tells the individual what he or she can do to live eugenically. A glossary and bibliography complete the work.

P. P.